NATURE

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PRINCIPLES AND PRACTICE OF CHROMATOGRAPHY

By Prof. L. ZECHMEISTER and Dr. L. CHOLNOKY

California Institute of Technology, Pasadena
Late of Chemical Institute, University of Pecs

Lecturer at the Chemical Institute, University of Pecs, Hungary

Translated from the Second and Enlarged German Edition by

A. L. BACHARACH, M.A., F.I.C., and F. A. ROBINSON, M.Sc. Tech., F.I.C.

Biochemical Department, Glaxo Laboratories, Ltd., Greenford, Middlesex

Chemical Research Department, Glaxo Laboratories, Ltd., Greenford, Middlesex

With a Foreword by

Prof. I. M. HEILBRON, F.R.S.

Organic Chemistry Department, Imperial College of Science and Technology

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SCIENCE IN MODERN LIFE

DR. J. B. CONANT's address at the meeting of the Royal Society which followed a luncheon in his honour on March 20 added one more to the many utterances, among which Dr. Raymond B. Fosdick's review of the Rockefeller Foundation in 1939 is specially notable, indicating how clearly scientific workers in the English-speaking democracies have appreciated the seriousness of the threat to science and all other cultural and spiritual values of our civilization in Nazi power and philosophy.

It is true that, as President Roosevelt has said, unless we win there will be no freedom for either management or labour. The ultimate stakes are freedom of speech and expression, freedom of worship, freedom from wrong, freedom from fear. By winning we strengthen their meaning, increase the structure of mankind and strengthen the dignity of human life.

The struggle, however, no less than the reconstruction to follow, will demand some sacrifice of privileges until success is achieved. Restraints must be accepted for the service of security, the improvement of standards of healthful living and the provision of markets for manufacture and agriculture. In peace, as in war, clear and resolute thinking is required to determine the limits which can wisely be accepted without detriment to that creative thought, that fearless, disinterested search for truth upon which man's real progress always depends.

It is at this point in the relations of science and society that there is a decided clash between two schools of thought which has tended to darken counsel. The supreme importance of freedom of thought, of teaching and of investigation if science is to advance or even exist, and if creative minds are to be brought to bear on the solution of the many problems confronting mankind or to express in fresh forms the aspiration of man's spirit, is not doubted by those who stand together in the struggle against Nazi tyranny. It is no service, however, to that cause, to refuse to recognize, as Prof. M. Polyani and others do, that science itself is to some extent a social activity, the direction and extent of which are determined at least in part by the society in which the man of science finds himself.

Recognition of this fact, which has recently been ably argued in a pamphlet, "Science and Socialism", issued by the University Labour Federation, is fundamental to any constructive attempt to remedy the present position, or indeed ultimately to scientific advance itself. We have here one main and sufficient reason for the keen interest and sympathy of men of science everywhere in the struggle against domination to which the British Commonwealth is committed. They at least have been quick to recognize that the control of man over Nature, the making of the machine the servant and not the master of mankind, and that the "world of increasing hope and enjoyment for the common man, the world of honoured tradition and expanding science", of which Mr. Churchill has spoken, are not to be had in a world dominated by totalitarian tyranny of any form.

To maintain to-day the isolation of science from the problems of life, whether of war, of unemployment, of disease and poverty is as absurd as to maintain the mutual independence of electricity and magnetism. We must at least attempt to think dialectically about the relations of science with society if science itself is to exert its full creative and productive powers, still more if society

is to attain that higher level of living and of civilization which scientific advance has already made possible.

To recognize, however, that science changes its social environment and is itself modified by that environment, that the extent of scientific resources and the direction in which they are used are dependent on the nature and outlook of the society in which the man of science works, is quite another matter from admitting the right of external authority to intervene in the quest for truth, enlarging the knowledge of the universe, which is of the essence of science. Scientific workers may not be able to obtain adequate support for carrying out a particular investigation unless they have succeeded in making its purpose sufficiently intelligible to enlist the sympathy of those controlling public funds. Their work is to that extent conditioned by the general outlook and culture of the community. It is another matter altogether if the community through its leaders or representatives should attempt to dictate the methods to be used and the results to be obtained in the investigation.

This is the point which is commonly overlooked by so many who have recognized the reaction of society on science. Their enthusiasm for the different position which, on paper at least, science and the scientific worker occupy in the U.S.S.R., sometimes betrays them into uncritical adulation of that position. "Science and Socialism", referred to above, is no exception. The planned control of scientific research does indeed imply that science is a concern of the State and establish the existence of a social function of science. It affords further evidence of the exiguousness of the distinction between 'pure' and 'applied' science. It emphasizes the need for every citizen to approach the problems of life with a scientific outlook.

To maintain further, however, that in such a society there is no distinction between the professional man of science and the layman is at once to incur the charge which Prof. Polyani brings against any totalitarian regime in the "Contempt of Freedom". There is no peculiar 'holiness' in science, and they do it a disservice who assert that science is something mysterious which cannot be comprehended by the ordinary citizen. To eliminate jargon and promote the effective exposition of what science is doing is one of the first duties of the man of science and one of the greatest safeguards of freedom of thought in a democratic society.

Scientific workers must admit the reactions on the direction and extent of their work which are imposed by the nature of the society in which they live. They can co-operate with their fellow citizens to widen those bounds and minimize any restraints. They can themselves seek to direct their work to serve the needs of society, the purposes of the community of which they are members. They can, however, in no wise admit the direction of their work by any external authority.

It is this allegiance and this clash of loyalties that is overlooked and obscured by so many writers of 'left' views. The danger of a totalitarian regime to scientific work and freedom does not depend on whether that regime is Communist or Fascist in political thought. The scientific worker's first allegiance is to truth itself, and his first duty to his fellow men the defence of feedom of thought and investigation and utterance. On that point there can be no compromise, and any support he may give to the furtherance of a political programme must not be inconsistent with that allegiance.

"Science and Socialism" betrays an obtuseness on this point no less lamentable than that of the Polyani school to the idea of planning. Scientific workers as a body are only too anxious to see society enjoying the higher standard of living, the ampler leisure and richer culture which science has made possible and to co-operate in the establishment of such an order. Their support cannot be given as implying unconditionable alignment with any political system or party. They must retain their freedom of thought and judgment. The scientific attitude cannot be abandoned even if it conflicts with an official social philosophy.

It can be readily admitted that there are many things to be redressed in the present order of society and that scientific advance itself has directed attention to such weaknesses. A capitalist society, however, has no monopoly of weaknesses and scientific investigation might equally lead to exposures calling for drastic reform under a socialist or any other conceivable order of society. The scientific worker cannot pledge himself in advance to keep silence as the price of support from any political party or system. He is first and foremost a servant of truth and bound to follow wherever she leads.

It is indeed possible that that loyalty might well lead scientific workers to a fairly general support of many tendencies generally regarded as

socialist but for the excess which characterizes the statements of socialist propagandists as in "Science and Socialism". They have indeed no inherent objection to the planning of science, but whether that is done by men of science alone or in co-operation with others there are real difficulties. Mannheim's "Man and Society in an Age of Reconstruction" remains the outstanding contribution to the evolution of a type of planning in which democratic control could be maintained by institutional safeguards.

The continuance of scientific advance and the very existence of civilized society depend on the establishment of an ordered society in place of the anarchy and *laisser-faire* of the last twenty years. That in itself implies some measure of planning, and the urgent task to which scientific workers must make their own contribution is that of determining the conditions and technique by which we can advance to a higher form of freedom involving social co-operation and the maintenance of individual vitality and initiative in a planned society. This task will call for creative thought, for the steady widening of the fields in which scientific thought and method are brought to bear —an experimental attitude in social affairs and a readiness to learn from the lessons of history, which are far more characteristic of a democratic than of any type of totalitarian regime. Scientific workers can only make that contribution by clearing their minds fearlessly from all prejudices and preconceived ideas and by refusing to allow their loyalty to truth to be compromised by any support which they may, in the defence of freedom or the establishment of order and the furtherance of reconstruction, be called upon to give to a political party or institution. They must learn the art of co-operation with their fellow citizens, of interpretation and exposition, of spreading a scientific outlook and approach to the problems of society and of world order, abandoning all claims to be a class apart, without surrendering that higher loyalty which bids them follow wherever truth may lead them.

MIGRATION

Migration to and from the British Isles

Problems and Policies. By R. S. Walshaw. (Issued under the auspices of the School of Social Sciences and Administration in the University of Liverpool.) Pp. 94. (London: Jonathan Cape, Ltd., 1941.) 5s. net.

DURING the course of the present War population problems necessarily recede into the background. In a violent life and death struggle for our very existence as a nation, we do not need to consider, as immediately applying to our war effort, those interesting questions of births and deaths and migration which produce their effects over long periods of time. They have their grave importance in normal times, and they have had their cumulative effect in putting our man-power exactly where it is. If we were obliged—which God forbid—to contemplate a succession of gigantic world-wars, then the whole population structure would have to be studied with the single view of providing men for the services and for munition production, allowing only a minimum of those ineffective members of society who are chiefly to be found among the aged.

Mr. Walshaw's excellent little book is issued under the auspices of the School of Social Sciences and Administration in the University of Liverpool. The introduction is by Mr. Caradog Jones, reader in social statistics in that University, who rightly remarks that when peace comes again there will probably be an increase of public interest in migration questions. To show how such questions can affect even our war effort, we may quote his statement that the Dominions "are only ready to welcome the strong, the skilled, the intelligent." If such a drain of our best elements were to continue for any length of time, it is clear that the ultimate population would be less able to wage a successful war.

It is not always realized how large the drain has been in the past. Thus, during the nine years from 1905 until 1913 inclusive, the average net annual outward migration, from the United Kingdom, was 183,000; and even after the War of 1914–18 the average net annual outward migration for the six years 1921 until 1926, inclusive, was 120,000.

We all know how the birth-rate has been falling in Great Britain, and that the population, in spite of appearances, is not reproducing itself. Various estimates have been made as to the year in which we shall reach a stationary condition of population, and, as a rough guide, it may be said that if there had been no war, that condition would have been reached sometime about 1950. Now that we are at war we must expect that stage to be reached sooner. The author points out that, when we have

reached a state in which there will be a natural decrease, in place of the increase to which we are accustomed, "the subject of external migration will begin to occupy a far more important place in the public mind than it does now."

One of the chapters deals with the ebb and flow of British migration to and from the continent of Europe, and it is stated that of the British in Europe in the year 1930, half were resident in France. "During the sixteen years 1922 to 1937 British immigration into the United Kingdom from Europe amounted to as many as 233,000 people". By the end of 1937 very few British subjects remained on the Continent, and one can read this with a certain sense of relief; though to counterbalance this we must remember that 67,000 British subjects are in the hands of the Germans, in the oldest part of the Empire, namely, the Channel Islands.

The most important matter discussed by the author is British migration to and from the Dominions, and he mentions the significant fact that, for the first time in our history, in 1931 we gained in population by inward migration. Most of those who came back were recent settlers who had failed to establish themselves and were stranded when the great depression arrived. With regard to the general question of migration to the Dominions, certain principles have been accepted by all the Governments concerned. It was, for example, agreed that a better distribution of the white population of the Empire is desirable, and that emigration required constant co-operation between the home and oversea authorities, and that full use should be made of the agency of such bodies as the Salvation Army, the Y.M.C.A., and so on. But the whole complex matter deserves study in the book before us, and Mr. Walshaw sets out clearly the various changes of policy and circumstance. A few matters stand out: thus, the Dominions have made it clear that they cannot absorb additional secondary producers unless there is a large increase in the number of primary producers.

On the question of the numerical effect of emigration from Great Britain, the author makes the following statement, which would seem to be incorrect: "In the British Isles . . . even after allowing for the losses of the war [of 1914–18], the cessation of emigration caused the population to be over a million more than it would have been had the pre-war trend continued". Actually it is easy to show that, if there had been no war, the population of Great Britain would have been some two millions greater than it actually was, as shown by the census of 1921.

It may be remembered that, at the International Population Congress, which was held in Paris in 1937, Prof. A. M. Carr-Saunders and Mr. Walshaw contributed a paper on recent population movements in Ireland, which raised the question as to whether the population of Great Britain was not likely, if present tendencies continued, to be eventually of predominantly Irish descent. Mr. Caradog Jones says in the introduction to this book, "Men accustomed to town life have been encouraged to settle in countries where the primary need is for workers on the land, their places being taken by countrymen from Southern Ireland". Mr. Walshaw remarks that "In view of the unimpeded influx of Southern Irish citizens into Great Britain . . . expenditure by the United Kingdom on the transference of its own citizens to the Dominions would already appear somewhat anomalous".

The question deserves impartial and objective study. To begin with, we must realize that southern Ireland is a small country and that the number of migrants that it sends out, nowadays, does not reach the huge proportions of the past. Southern Ireland uses emigration as a safety-valve, and its population remains nearly constant, with a tendency to decrease; between 1924 and 1936 the average excess of births over deaths was about 17,000 a year. The census of 1936 gave the population as 2,968,000, a diminution of 3,500 since 1926.

If we consult the figures of the census of Great Britain of 1931, we shall find that there were resident in Great Britain at that time, 359,163 persons who were born in southern Ireland; of these, 55,487 were living in Scotland. Taking the population of Great Britain in 1931 as practically 45 millions, it will be seen that the percentage of persons born in southern Ireland was 0·8. Of course, to those born in southern Ireland we should add those of Irish parents but born in Great Britain. There are indirect ways of getting at this figure, but not very exact. Perhaps the southern Irish now living in Great Britain might amount to 4 per cent of the whole population. There is some reason to suppose that this stock breeds rather more rapidly than the British stock.

As to quality, a large number of Irishmen who migrate to Great Britain find employment on heavy labouring work, but more than half the immigrants were women. The author thinks that some, at least, of the male immigrants are above the average in physical capacity. In the post-war world, this particular population problem should be studied attentively. Meanwhile, if the southern Irish now living in Great Britain throw in their lot whole-heartedly with the rest of us, during this period of the War, so critical for them as well as for us, we shall have no cause to complain.

EDUCATIONAL WORK IN THE UNITED STATES

(1) Educational Yearbook of the International Institute of Teachers College, Columbia University, 1940
Edited by Prof. I. L. Kandel. Pp. xiii+397. (New York: Columbia University, 1940.) 3.70 dollars.

(2) Student Teaching
An Experience Program. By Raleigh Schorling. (McGraw-Hill Series in Education.) Pp. xiii+329+33 plates. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 17*s.* 6*d.*

(3) Psychology in Education
By Herbert Sorenson. (McGraw-Hill Series in Education.) Pp. xiv+489. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 19*s.*

(1) THE determination of the English-speaking peoples to maintain educational thought and practice at a high level, even in the present distracted times, is illustrated by these three books from the United States. The first of them is the seventeenth annual issue (1940) of the well-known "Educational Yearbook", devoted on this occasion to problems of adult education. On this subject, profoundly important to democracy, the yearbook enables us to compare notes, not only with the United States, but also with the British Commonwealth of Nations, and with many other countries. One is not suprised to learn, however, that the editor found it "unfortunately impossible to secure articles from Soviet Russia and Nazi Germany".

The articles on Denmark and the Netherlands were written before the great devastation, and may still be taken, so far as they go, to represent the real mind of these stricken lands. As to England, it is here placed on record that adult education has been deemed far too important for maintaining the morale of the nation to be allowed to languish.

One of the general impressions left by a perusal of this comprehensive yearbook is that no definition of what is meant by adult education is yet possible. It may mean anything from courses at the university level to what the editor rather grandly calls "the liquidation of illiteracy"; that is, teaching people to read. Another clear impression conveyed by these reports is that sound adult education must come in response to the felt needs of the people, and from nowhere else. It cannot come by way of formal organization provided from above. "It is most successful and vigorous when it is spontaneous and springs from a desire to learn and an interest in self-education". At first sight it is strange to find that for adult education at its best we have to look to usually laggard England rather than to Scotland or the United States. This is partly due to the far greater provision for university education in these two countries, but partly also, we believe, to causes more creditable to England.

A remarkable fact, of special interest to readers of NATURE, is that even in English adult education there is only a slight demand for courses in science. Why, it may well be asked, should students in classes arranged by the Workers' Educational Association show such an overwhelming desire for social and literary subjects as to throw science definitely into the shade, notwithstanding the immensely important contribution of science to modern civilization? Even the relatively few science courses that are asked for are mostly elementary, and do not involve any serious scientific discipline. The report in the yearbook explains the fact by "the failure on the part of scientists to make clear the humane aspects of scientific study", and the inability of scientific specialists "to interpret their subject to others who are not specialists like themselves". But the recent provision of "mathematics for the million" is perhaps one sign among many that science is recovering its voice.

I am not sure, however, that this is the only way, or even the really effective way, in which science can be made to appeal to the more intelligent classes of the community. Men of science must, I think, address themselves to the task of breaking down the barrier set up last century between science and the humanities. It is not merely a question of making science easier to grasp, but a question of showing that science truly so called is from end to end as human as anything can be. The task will not be easy, for since the industrial revolution science has bestowed upon us not only marvellous benefits, but also an amount of noise, smoke and greasy dirt which apparently makes the W.E.A. student willing to forget science awhile, with all its works and ways.

(2) The breaking down of the old barrier between the scientific and the humane is exemplified in the work entitled "Student Teaching", a recent addition to the excellent McGraw-Hill Series in Education. The book is meant for students preparing to become teachers. Two generations ago, a similar book, whether British or American, would have contained no trace of the precision

which we associate with scientific method. A generation ago—*experto crede*—traces of that method began to appear. In the present volume the scientific method is well to the fore, chiefly in the form of statistics, charts, and "check-lists", some of which, by the way, would seem to most English teachers embarrassingly personal. The reader is supposed to be almost as well acquainted with intelligence quotients as with the multiplication table; but he is warned against accepting both as of equal validity.

Of course there is little that is of real scientific value in all these devices, but they do suggest that in pedagogy the scientific attitude has come to stay. Yet the author has written a rather jolly book, furnished with telling illustrations, and everywhere suggesting that a teacher deals with live children and not with laboratory abstractions.

(3) A further addition to the McGraw Series takes for its theme education as psychology sees it, there being few fundamental problems in education which do not find a place in Dr. Sorenson's book. They include the problems of growth and development, emotional reactions, behaviour, capacity to learn and the best methods of learning, measuring and marking achievement, and the forces of heredity and environment. The author adheres to no one school of psychology. He is, however, a thorough modernist. He represents in the main the new psychology of experiment, not the old psychology of introspection.

Dr. Sorenson's book provides a good example of the scientific humanism for which I would plead. It is to be hoped that the book will become known in Britain. Finally, I should like to see more evidence that the best British work in educational psychology (for example, that of Prof. Cyril Burt) is known in the United States.

T. RAYMONT.

CONTRASTS IN FIRST-YEAR GEOLOGY

(1) Introduction to Geology

General Geology, by Dr. E. B. Bailey; Palæontology, by Dr. J. Weir. Pp. xii+498. (London: Macmillan and Co., Ltd., 1939.) 18*s*.

(2) Geology

Principles and Processes, by Prof. William H. Emmons, Prof. George A. Thiel, Prof. Clinton R. Stauffer, Prof. Ira S. Allison. Second edition. Pp. xii+451. (New York and London: McGraw-Hill Book Co., Inc., 1939.) 21*s*.

A SUBJECT of such wide scope as geology cannot be presented fully in a first-year university course, and the difficult problem of selection must therefore be solved by lecturers in the way most appropriate to the needs of their students. The two first-year text-books under review are examples of solutions so extreme that neither is likely to correspond very closely with average requirements. The first covers an unusually broad field and deals with minerals, rocks, structures and map-reading, crystallography and microscopical petrography, physical geology, palæontology and historical geology. The second, by a group of authors, three of whom are at the University of Minnesota, is restricted to a much more detailed account of the materials of the earth and of geological processes; earth history is omitted, except for a table of the main divisions and outstanding events of geological time.

(1) The "Introduction", for which Dr. E. B. Bailey is largely responsible, is based on the first-year lectures delivered at the University of Glasgow during the years of his professorship (1930–37). The chapters devoted to palæontology are written by Dr. J. Weir and make up a little more than a quarter of the book. Another colleague, Dr. W. J. McCallien, has contributed two-thirds of the numerous illustrations, all of which are line drawings. Most of these are clear and effective, but a few of the more complex subjects are not very satisfactorily portrayed.

It is disappointing to find that Bailey's treatment of his topics is of very uneven value, both in manner and matter. His style of writing is highly individual and informal: somewhat journalistic, often graphic and entertaining, generally easy to read, but all too often marred by colloquialisms and carelessness of phrase and definition. As an example of inconsequential writing, the following would be hard to beat: "In some of the interior States of America it is laid down by law that salt must be fed to cattle. The reason is that our blood and other juices are salt solutions" (p. 78). Another curious statement (p. 115) is that the simple chemical composition of ore minerals is responsible for their habit of occurring in veins. The definition of a volcano—"an accumulation of material brought to the surface in a molten condition or by hot explosive gases" (p. 225)—is quite inadequate. Is a bed of volcanic ash a volcano?

The treatment of crystallography is very unorthodox, and the author's intention to help the

student introduces difficulties that should not normally arise. The fact that the Miller indices of a crystal face are proportional to the parameters divided by the respective intercepts is not stated. What can a student be expected to gather from the statement that "The biggest index of a face symbol shows the axis-end from which the face starts" (p. 139)? The attempt to elucidate optical properties is seriously confused by the innovation (p. 161) of referring to the extinction directions of any birefringent section as *X*-er and *Z*-er axes (instead of saying they are relatively 'fast' and 'slow'), irrespective of the orientation of the section or of its uniaxial or biaxial character. Moreover, there are several mistakes. The refractive index of individual sections of a mineral in a rock slice is said to "range from zero to a definite maximum" (p. 162), and optic axes are said to be isotropic (p. 163).

The general liveliness of the book may be exemplified by the prophecies that much of the Yellowstone Park may be blown sky high within the next few thousand years (p. 76), but that during this time New York is not likely to be dangerously shaken by earthquakes (p. 244); and by the statement in a brief chapter on geophysical surveying that "A few good scientists believe that they possess the dowsing faculty". A particularly daring flight of fancy (p. 94) is that "What may be a single sill carries Stirling Castle, the Forth Bridge at Queensferry and long stretches of the Roman Wall in Northumberland (the Great Whin Sill of the North of England)". On p. 236 we read that "What is probably the same sill comes down to earth in the Lanarkshire coalfield". Actually, not even the 'Great Whin Sill' is a single sill.

In Part VII (pp. 381–479), which deals with historical geology, Bailey is at his best, and teachers and students alike will find this section both interesting and stimulating. This comment is equally true of Weir's highly competent survey of palæontology in Chapter v and Part VI. The biological aspects are much more thoroughly reviewed than in other elementary books and the student is systematically guided, with the aid of a profusion of admirably chosen illustrations, through the complexities of a subject that is here made much less forbidding than usual. The treatment is well balanced, vertebrates and plants receiving a full share of attention as well as invertebrates. Dr. Weir is to be congratulated on a presentation which is a model of its kind.

(2) The Minnesota "Geology" is the second edition of a text-book which first appeared in 1932. It has been revised, rearranged and completely reset, and in its now greatly improved form it becomes one of the best of the American books of similar scope. The first edition contained a chapter on earth history which has now been omitted, but other chapters have been expanded and new ones on sediments and igneous rocks introduced. There are also many new and original illustrations, by no means confined to subjects from North America, including beautifully reproduced photographs, well-designed block diagrams and other effective figures and maps, all of which add to the general appeal and educational value of the book. It was a happy thought to furnish many of the illustrations with inset maps showing unfamiliar localities. On the other hand, no locality at all is given for Welch's well-known photograph of a pothole in Glenariff (Fig. 137), which, moreover, is said to be after R. S. Tarr. In a few other cases the failure to indicate the scale of an illustration reduces its value; for example, Fig. 164, an arresting and highly instructive view of folds in the ice of the Ross Barrier.

The treatment is clear throughout, and generally logical and systematic; precise data are presented whenever possible; and the text is attractively written. The chapters on the atmosphere, natural waters, and sediments are particularly well done, though river meanders—always a difficulty—are unduly neglected. The clear distinction between processes of external and internal origin is somewhat blurred by the introduction of a class of sediments of magmatic origin and by the use of the term metamorphism to include replacement by groundwaters.

The later chapters, dealing mainly with internal processes, fail to reach the high standard attained in the earlier part of the book and are relatively old-fashioned in outlook. Another surprisingly bad definition of a volcano appears. This time "a volcano is an opening in the earth's crust through which hot rocks are thrown out" (p. 285). Details are given of many volcanoes and their eruptions, but they are not presented so as to build up a scientific picture, and no reference is made to the heroic and illuminating work of Perret. On p. 319 basalt is given as the aphanitic equivalent of peridotite as well as of gabbro. Magma formation is wrongly ascribed to relief of pressure by faulting and folding (p. 320). The gneiss figured on p. 389, and referred to as an example of a rock formed by dynamic metamorphism, is obviously a migmatite. Mountain building and other earth movements are said to be probably due to earth shrinkage. Alternative hypotheses receive no mention, nor is there any discussion of the many difficulties that stand in the way of accepting the shrinkage hypothesis.

A chapter on "Probable Conditions within the Earth" deals with geomagnetism and evidence from isostasy and seismology, but makes no

mention of the outstanding work of Vening Neinesz. The nickel ore of the Sudbury intrusion is still given as an example of magmatic segregation, despite the fact that it is now known to be of later introduction (p. 423). The selected bibliographies with which most of the chapters are furnished require considerable revision. Some of the standard works to which reference is made have appeared in later editions than those cited.

Defects of the sort mentioned above make one hesitate to recommend the book as a whole for general reading, but so much of it is admirable that it should certainly be given a place in every college library. With further improvements on the lines indicated, a third edition, which should certainly be called for in due course, might well take first place among elementary text-books on physical geology.

PROGRAMME FOR SOCIAL REFORM

Programme for Victory

A Collection of Essays prepared for the Fabian Society by Prof. Harold J. Laski, Harold Nicolson, Herbert Read, Prof. W. M. Macmillan, Ellen Wilkinson, G. D. H. Cole. Pp. vii+187. (London: George Routledge and Sons, Ltd., 1940.) 5s. net.

THE common element in these six lectures is the belief of all the authors that something called the 'old order' is gone for ever, and that the only issue of our time is the question what is to take its place. Broadly speaking, the old order was the world of unplanned production and distribution on one hand, and international anarchy on the other. All are convinced that planning has come to stay, and that the independent State, certainly the small independent State, has no future. What they are not so certain about is whether this planning will or will not be carried out at the expense of personal freedom; whether we shall plan for social equality or for the protection of privilege; and whether it is to be conquest or the voluntary coming together of peoples in free supra-national associations which is to put an end to the proud sovereignty of the nation-State. It is the choice between these alternatives that the authors are concerned to shape.

Beyond this the word 'programme' is something of a misnomer. For with one or two exceptions there are no very concrete proposals in these lectures. There are general principles, and there is a good deal of eloquence. Prof. Laski is the most definite. He does say explicitly that a programme of social reform must be put in hand while the War is on, if fine words about democracy are to carry conviction to our oppressed allies. He suggests that that programme should include the repeal of the Trade Disputes Act, the abolition of the household means test, better allowances to the sick, the injured and the aged, and an effort to rescue public education from the rack and ruin into which it has been allowed to dissolve.

Mr. Harold Nicolson on world government is by contrast studiously vague. He says that he has deliberately chosen this title in order to avoid getting embroiled in the prejudices associated with "League of Nations" or "Federal Union". This tactful avoidance of prejudice, however, results in his telling us nothing at all about the kind of world government that he envisages, except that it would be a "loose Federation" based upon the "free co-operation of all free peoples". What kind of powers this Federation is to have, how it is to be organized, over what geographical area its writ is to run—for answers to such precise questions as these the reader will turn to this distinguished diplomat in vain.

Perhaps the most fresh and stimulating of all the contributions is that in which Prof. Macmillan deals with the problem of the British Colonial Empire. The significant fact upon which this lays emphasis is not that the Colonial peoples have been shamefully exploited (although sometimes they have); but that they have so little to exploit. We did not reduce them from a state of paradisical bliss to their present plight of disease and poverty. Their standards were wretched enough before ever the whites came interfering; and the great needs are, and always have been, money for development and for civilized services of all kinds.

In the remaining papers Mr. Herbert Read expresses fears lest a bureaucratic socialist State should stifle the voice of free artistic expression; Miss Ellen Wilkinson demands social justice; and Mr. Cole sums up with a moving plea for a liberal socialism which will combine the values of nineteenth century democracy with the techniques of twentieth century economics.

With the general attitude of these authors there will be widespread sympathy and agreement. But the book is not a programme. It merely gives an urgent stimulus to the demand that a programme consistent with this attitude should be quickly and precisely formulated. BARBARA WOOTTON.

A Junior Biology

By Kenneth C. Sparrow. Pp. viii+187. (London: William Heinemann, Ltd., 1940.) 4s.

THIS book is designed to cover a scheme of work for the first two years (of a five years course), thus leading up to the School Certificate years. In biology, of all subjects, it is extremely difficult to make a judicious selection of material which will provide a connected and correlated course; but the author has succeeded well. Yet, many teachers of biology would be ready to join issue with the author for considering seeds and seedlings and the development of young animals so early in the course. Though the logical thing to do, from the biological point of view, it is exceptionally difficult from the educational point of view, for children are not familiar with seeds and seedlings, neither are they with incubating eggs. They are, on the other hand, with mature plants and birds, and that is where many teachers would prefer to begin.

There are some attractive photographs in the book, but they seem to have been chosen too casually; for example, Fig. 5, entitled "A Typewriter", shows more of a sturdy youngster than the machine it is intended to illustrate; the compression ignition engine cannot convey anything to a reader of such tender years, neither can the two excellent photographs of the development of the chick; the diagram of a model of the lungs would convey more if two illustrations were given representing the two extreme positions; and it is always misleading to group several animals or plants together without indicating their relative sizes as is done in Fig. 29 where the octopus is indicated as being not much bigger than the snail.

The book is essentially practical in outlook, which is all to the good. It should satisfy those teachers who accept this type of course. The work is so designed as to stimulate the spirit of discovering things and finding out their meaning. This is very desirable since though it may be that the young reader will forget most facts stated in the book, he ought to leave it with a real desire to discover things biological for himself.

Semimicro Qualitative Analysis

By William Lloyd Evans, Alfred Benjamin Garratt and Laurence Larkin Quill. Pp. vii + 246. (Boston, New York, Chicago and London: Ginn and Co., 1940.) 10s. 6d. net.

RECENT years have witnessed in inorganic chemistry the developments of a new technique involving analysis by semimicro methods, and the authors of "Semimicro Qualitative Analysis" have produced a most useful book for students in this field. A tremendous amount of detail, rendered more compact by an extensive system of abbreviations, has been compressed into this volume which includes five sections: an introduction describing apparatus, reagents and methods of procedure, one section each on the identification of cations and anions, a condensed outline of the theory of qualitative analysis, and finally a series of appendixes which is very comprehensive. The make-up of the book is somewhat novel in that it is of the loose-leaf variety, containing block outlines of methods, and flow sheets of experiments. It is therefore both a text-book and to some extent a laboratory note-book.

Semimicro analysis is not meant to displace the normal macroanalysis where larger quantities of materials are manipulated, but a course of this new technique supplies valuable training for a student since many of the rarer compounds are now, of necessity, analysed by micro methods.

The experimental details, which follow closely the better-known classical methods of analysis, are very clearly stated with ample explanations and directions. The theoretical part is couched in simple terms, but contains sufficient detail to enable the student to appreciate the methods employed in the experimental section. The appendixes will be found exceedingly useful since they contain much detailed instruction on the preparation of reagents, care of apparatus, general reactions of groups together with the usual tables of constants and lists of elements and symbols.

A course of microanalysis is almost essential now to aspiring chemists, and to such students this volume can be recommended with confidence as an indispensable item of their equipment.

Practical Pharmaceutical Chemistry

By F. N. Appleyard and Dr. C. G. Lyons. Fourth edition. Pp. vii+174. (London: Sir Isaac Pitman and Sons, Ltd., 1939.) 6s. 6d. net.

THE fact that this text-book by Appleyard and Lyons has made its fourth appearance in ten years is sufficient evidence of its popularity. This new edition differs from its predecessors only by a slightly expanded chapter on qualitative organic analysis.

Since this work is intended for those students entering for the Chemist and Druggist Qualifying Examination, it is not exhaustive, in that the work necessary for the Preliminary Scientific Examination is only reviewed briefly. Instead attention is focused on more advanced topics. At the same time adequate instructions and explanations are given of the principles underlying analyses of pharmaceutical products, particularly volumetric analysis.

The fact that the experimental details are condensed to fit in with a special curriculum probably accounts for the fact that some of the sections, for example, those on the assay of alkaloids and on permissible adulterants, appear rather short. In those sections and in the chapters on gasometric and gravimetric methods, the authors have obviously selected specimen examples to illustrate the technique required. The sections on organic preparations and organic qualitative analysis are very well done, and the field covered should prove adequate for the purpose of pharmaceutical students.

The practical work described in the text-book forms a suitable complement to the theoretical studies necessary in this course. Undoubtedly this new issue will maintain the high popularity earned by previous editions.

CARBON DIOXIDE ASSIMILATION IN HETEROTROPHIC ORGANISMS

By Dr. H. A. Krebs,

The Department of Biochemistry, University of Sheffield

BEFORE 1936, only autotrophic organisms—plants and a small group of bacteria—were known to assimilate carbon dioxide. Recent experiments have shown that carbon dioxide is also assimilated by many heterotrophic cells, including animal tissues. Although this reaction provides no more than a small fraction of the total carbon requirements of heterotrophes, it is of great interest, for it is one of the metabolic processes which is indispensable for the normal life of animal tissues, bacteria and moulds.

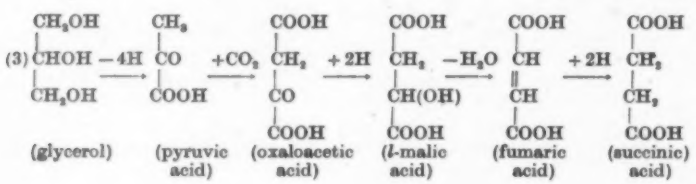
Carbon Dioxide Assimilation in Propionic Acid Bacteria

In 1936 Wood and Werkman[1], studying the fermentation of glycerol by propionic acid bacteria, made the unexpected observation that the end-products of the fermentation—mainly propionic and succinic acids—contained more carbon than had been added in the form of glycerol. Since the medium contained calcium carbonate (to neutralize the acids formed during the fermentation) the authors suspected that this might have provided the excess of carbon. In fact less carbonate was recovered than was originally present, and the authors thought it justifiable to conclude that propionic acid bacteria are able to utilize carbonate or carbon dioxide and to convert it into an organic compound. In 1938, Wood and Werkman[2] showed that the quantities of carbon dioxide used, and of succinic acid formed, are approximately equimolar. The experimental data conform with the assumption that there are two main reactions when glycerol is anaerobically fermented, namely:

(1) $CH_2OH.CHOH.CH_2OH \longrightarrow COOH.CH_2.CH_3 + H_2O$
(glycerol) (propionic acid)

(2) $CH_2OH.CHOH.CH_2OH + CO_2 \longrightarrow COOH.CH_2.CH_2.COOH + H_2O$
(glycerol) (succinic acid)

Some of the intermediate stages of reaction (2) are outlined by the following scheme of Wood and Werkman[2,3]:



According to this scheme pyruvic acid is the intermediate which actually fixes the carbon dioxide. The primary product of the fixation reaction is oxaloacetic acid; this afterwards undergoes reduction to succinic acid.

Scheme (3) is now supported by three independent sets of observations:

1. The utilized carbon is present in the carboxyl group of succinic acid. This was shown by Wood, Werkman, Hemingway and Nier[4] with the help of carbon dioxide containing the heavy isotope ^{13}C.

2. Fumaric and malic acids, the postulated precursors of succinic acid, can be detected in the medium[5]. This applies to anaerobic conditions where succinic acid cannot be converted into fumaric and malic acids. Scheme (3) is the simplest, and therefore the most satisfactory, explanation for the simultaneous formation of the three dicarboxylic acids.

3. Added oxaloacetic, fumaric and l-malic acids are readily reduced to succinic acid as expected according to (3)[5].

It is probable that the assimilation of carbon dioxide by way of reaction (3) occurs in many other bacteria, although *B. coli* is so far the only other micro-organism for which the absorption of carbon dioxide has been directly demonstrated[4,6,7]. The occurrence of reaction (3) in other bacteria is indicated by the fact that they, too, form succinic acid from carbohydrate, glycerol or pyruvic acid. The evidence favours the view that the succinic acid is formed in these cases in the same way as in propionic acid bacteria, namely, through reaction (3). Experimentally, there is an important difference between propionic acid bacteria and other organisms; in the latter the (assumed) uptake of carbon dioxide is counterbalanced by the simultaneous production of carbon dioxide; carbon isotopes are therefore the only means of obtaining direct proof of the carbon dioxide fixation. The special position of propionic acid bacteria is due to the fact that from these organisms side reactions producing carbon dioxide are absent when glycerol is fermented.

Carbon Dioxide Assimilation in Animal Tissues

The discovery of carbon dioxide assimilation in animal tissues arose from a study of

the fate of pyruvic acid in pigeon liver. This tissue is capable of synthesizing a 5-carbon chain from the 3-carbon compound pyruvate. Glutamine ($CONH_2.CH_2.CH_2.CHNH_2.COOH$) is formed from ammonium pyruvate[8], α-ketoglutaric acid ($COOH.CH_2.CH_2.CO.COOH$) from sodium pyruvate[9]. α-Ketoglutaric acid is very probably an intermediate in the synthesis of glutamine. The synthesis of α-ketoglutaric acid was found always to be accompanied by a synthesis of malic acid[7]. This observation provided the clue to the mechanism of the reactions taking place in the presence of pyruvic acid. Since α-ketoglutaric acid is known to undergo an oxidation to succinic acid and afterwards to malic acid, the simultaneous formation of α-ketoglutaric and malic acids might be expected if sufficient oxygen is available. However, a detailed investigation of the conditions under which α-ketoglutaric and malic acids were formed made it clear that the bulk of the malic acid could not have been formed by the oxidative breakdown of α-ketoglutaric acid. Thus the conclusion had to be drawn that a synthesis of malic acid from pyruvic acid takes place in addition to the synthesis of α-ketoglutaric acid.

When this was first observed[7] it was already known[10] that α-ketoglutaric and malic acids arise simultaneously when oxaloacetic acid is added to animal tissues. The following anaerobic reactions occur in the presence of oxaloacetic acid[10].

(4) oxaloacetic acid ⟶ pyruvic acid + CO_2

(5) oxaloacetic acid + pyruvic acid → citric acid + CO_2

(6) citric acid ⟶ α-ketoglutaric acid + CO_2

(7) oxaloacetic acid ⟶ *l*(−) malic acid

When oxygen is absent the reactions (5) and (6), which are oxidative, are each coupled with the reductive reaction (7), and the net effect of (4), (5), (6) and (7) is thus :

(8) 4 oxaloacetic acid → α-ketoglutaric acid + 2 malic acid + $3CO_2$

Since pyruvic acid yields α-ketoglutaric and malic acids in somewhat similar proportions the simultaneous synthesis of α-ketoglutaric and malic acids from pyruvic acid may be explained by the assumption that oxaloacetic acid is formed first from pyruvic acid and carbon dioxide :

(9) $COOH.CO.CH_3 + CO_2 \longrightarrow COOH.CO.CH_2.COOH$

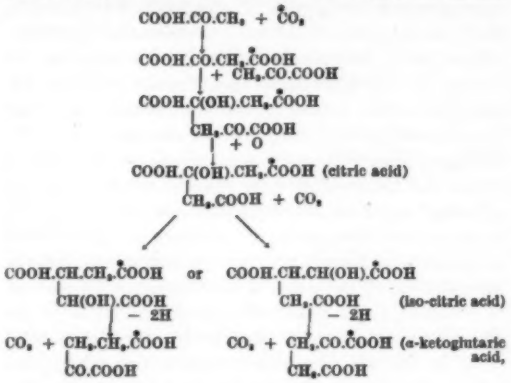
or

$$COOH.CO.CH_3 + H_2CO_3 \xrightarrow{-H_2O} COOH.CO.CH_2.COOH$$

and that this reaction, the 'carboxylation' of pyruvic acid, is followed by reaction (8). All the experimental results agreed with this assumption. Moreover, the rate of pyruvic acid disappearance was found to depend on the carbon dioxide pressure and this supported the view that carbon

SCHEME SHOWING THE FATE OF ASSIMILATED CARBON DIOXIDE IN PIGEON LIVER

(The carbon atom introduced in the form of CO_2 is marked with an asterisk. If a carbon isotope is used, two different forms of iso-citric and α-ketoglutaric acids both containing the isotope are formed.)



dioxide takes part in the metabolism of pyruvic acid.

Yet the evidence could not be regarded as conclusive so long as the absorption of carbon dioxide had not been directly demonstrated. In living tissues there are always metabolic processes in which carbon dioxide is produced, and these more than counterbalance the carbon dioxide uptake. In the balance sheet there is, therefore, a production of carbon dioxide. The use of carbon isotopes is the obvious method of tackling this problem. If carbon dioxide containing an isotope is used, the α-ketoglutaric acid synthesized from pyruvic acid should contain the isotope, if the mechanism suggested by the reactions (8) and (9) is correct (see the accompanying scheme). The decisive experiment was carried out by Evans and Slotin[11]. They used carbon dioxide containing the radioactive ^{11}C and found that α-ketoglutaric acid, as expected, contained radioactive carbon. This result completes the proof of the occurrence of reaction (9) in pigeon liver.

EFFECT OF VITAMIN B_1 IN ANIMAL TISSUES

The rate of pyruvate utilization is much reduced in the liver of pigeons suffering from severe beriberi, and addition of the vitamin restores the normal level of pyruvate removal[7]. This holds for conditions under which the synthesis of oxaloacetate from pyruvate and carbon dioxide is the chief reaction responsible for the removal of pyruvate and it may therefore be concluded that the 'carboxylation' of pyruvate is dependent on vitamin B_1. Since the carboxylation might involve more than one step—for example, a phosphorylation of pyruvate followed by the actual condensation with carbon dioxide—it remains to be

investigated for which particular step of the carboxylation the vitamin is required.

Barron and Lyman[13] assume that vitamin B_1 is a general coenzyme of pyruvate which takes part in a number of different reactions of pyruvate. There are, however, important arguments in favour of the view that the vitamin is a specific catalyst of the actual carboxylation and that it is directly concerned with the formation of the C-C linkage. The vitamin has no effect on the rate of pyruvate removal in the *muscle* of B_1 deficient pigeons[7], and this indicates that the vitamin is not a 'general' coenzyme of pyruvate. A second argument is based on the principle of enzyme specificity and on what is known about the action of vitamin B_1 in yeast. In yeast[13] vitamin B_1 (in the form of its pyrophosphate ester combined with a specific protein) catalyses the conversion of pyruvate into acetaldehyde and carbon dioxide :

(10) $CH_3.CO.COOH = CH_3.CHO + CO_2$

This reaction also occurs in moulds, plants and certain bacteria but is absent from animal tissues. The action of the vitamin in animal tissues must, therefore, be different from that in yeast. At the same time it is certain (Peters[14]) that here, too, the vitamin is concerned with the metabolism of pyruvate. Furthermore it is highly probable, in view of the high specificity of enzymes in general, that the reaction of pyruvate in animal tissues is analogous to (10). It has been suggested that this analogous reaction might be the "oxidative decarboxylation" of pyruvate leading to acetate and carbon dioxide :

(11) $CH_3.CO.COOH \xrightarrow{+\ O} CH_3.COOH + CO_2$

But as we know of no biological catalyst capable of catalysing an oxidation in one case, and a non-oxidative reaction in another, it is difficult to regard the catalytic mechanisms of (10) and (11) as analogous. The carboxylation of pyruvate, on the other hand, is analogous to (10): both reactions are non-oxidative, both involve a C-C linkage, and in both carbon dioxide is a reactant. They differ in that an α-ketonic acid is involved in (10) and a β-ketonic acid in (9) and in that (9), a carboxylation, is the reverse of (10), a decarboxylation. From the point of view of enzyme chemistry these differences are not fundamental, for it is known that one and the same catalyst can decarboxylate α-ketonic acids as well as β-ketonic acids[7] and that enzymic processes are reversible. The analogy between (9) and (10) is in these circumstances a very weighty argument in favour of the view that vitamin B_1 is specifically concerned with reaction (9).

The facts so far known do not make it necessary to assume that the vitamin catalyses other reactions in animal tissues, but it is by no means improbable that this is the case. McHenry[15] has shown that vitamin B_1 is necessary for the synthesis of fat in the intact organism. Since this is a complex process dependent on the supply of energy, the effect of the vitamin may be indirect; but it is also possible that a condensation analogous to (9) in which carbon dioxide is replaced by a carboxylic acid, occurs in the synthesis of fatty acids and is directly catalysed by the vitamin.

Effect of Vitamin B_1 in Bacteria

In staphylococci, vitamin B_1 is known to be required for the 'dismutation' of pyruvate :

(12) 2 pyruvate $\xrightarrow{+\ H_2O}$ lactate + acetate + CO_2

This was shown in a striking experiment by Hills who found that the rate of the dismutation is much reduced in staphylococci grown in a vitamin B_1 deficient medium and restored to the normal level by added vitamin[16].

If the function of vitamin B_1 in staphylococci is the same as in pigeon liver, that is, to bring about the synthesis of oxaloacetate, it should be possible to replace vitamin B_1 in Hills' experiment by oxaloacetate. Smyth[17] has shown that this is the case. In vitamin deficient staphylococci, oxaloacetate restores—temporarily—the normal rate of pyruvate dismutation. Oxaloacetate has no effect on "vitamin sufficient" cells. These facts are all explained if we assume that the vitamin acts by forming oxaloacetate from pyruvate.

It is not at once clear how the formation of oxaloacetate is connected with reaction (12). If the presence of oxaloacetate influences the rate of dismutation, as it does, the latter must be more complicated than the scheme (12) suggests. A satisfactory explanation of the oxaloacetate effect is afforded by the assumption that oxaloacetate participates in the dismutation. From what is known about the metabolism of oxaloacetate in other organisms, it is probable that oxaloacetate acts as a hydrogen carrier in the manner indicated by the following scheme :

(13) pyruvate + oxaloacetate $\xrightarrow{+\ H_2O}$ acetate + CO_2 + malate

(14) malate + pyruvate $\longrightarrow$ oxaloacetate + lactate

The net effect of these two reactions is (12). This hypothesis is supported by several experimental observations: the reduction of oxaloacetate to malate, and the oxidation of malate to oxaloacetate, postulated by the hypothesis, have been found to occur. Malate, moreover, has the same effect as oxaloacetate in vitamin deficient cells[17].

Biological Significance of Carbon Dioxide Assimilation in Heterotrophic Organisms

The significance of the carbon dioxide assimilation through reaction (9) obviously depends on the biological significance of the oxaloacetate formed by this reaction. So far two important functions of oxaloacetate are known. One of them, hydrogen transport in respiration, has already been mentioned. A second function is that of a parent substance of a number of essential cell constituents.

Hydrogen transport by oxaloacetate was first discovered in 1935 by Szent-Györgyi[18]. He observed that oxaloacetate is rapidly reduced to malate in respiring muscle tissue and that malate can undergo rapid re-oxidation to oxaloacetate. The system

$$\text{oxaloacetate} \underset{-2H}{\overset{+2H}{\rightleftharpoons}} \text{malate}$$

is now known to be an essential link in the respiration of many, if not all, animal tissues and also of a number of bacteria.

As a parent substance oxaloacetate takes part in the synthesis in animal tissues of a series of organic acids—citric, α-ketoglutaric, succinic, fumaric, malic acids—and of at least two amino acids, glutamic and aspartic acids and their respective amides, glutamine and asparagine.

Carbon Dioxide as a Growth Factor

Favourable effects of carbon dioxide on the growth of micro-organisms have been known since the work of Bang[19] in 1897, but early investigators believed that the effect of carbon dioxide was rather indirect, for example, by replacing oxygen and thus lowering the oxygen tension. More recently it has become clear that the effect is direct and specific. It has been found in numerous micro-organisms.

The widespread occurrence of the carbon dioxide effect may be taken to indicate that carbon dioxide takes part in some fundamental metabolic process, common to many organisms. The synthesis of oxaloacetate is a reaction sufficiently fundamental to offer an explanation for the necessity of carbon dioxide. This hypothesis can be experimentally tested. If it is correct, it should be possible to replace carbon dioxide by malate, or fumarate, or asparagine, or other substances which can serve as a source of oxaloacetate.

Carbon Dioxide and Anaerobiosis

The fact that air inhibits, or prevents, the growth of "anaerobes" can in many cases be explained by a simple chemical theory[20]: anaerobes lack the enzymic catalase, but at the same time they possess enzymes which cause molecular oxygen to react with the hydrogen of substrates. The end-product of this reaction is hydrogen peroxide. The latter oxidizes, and thus destroys, vital cell constituents.

The absence of catalase, however, does not account for *all* the inhibitory effects of 'air' on bacterial growth. Propionic acid bacteria (with the exception of one species) contain a powerful catalase. Yet these organisms grow poorly on the surface of agar, whilst growth is abundant in the deeper layers of agar stab cultures where the conditions are semi-anaerobic. Werkman and Brown[21] go so far as to call propionic acid bacteria 'anaerobes'. Van Niel[22] speaks of a "strong tendency towards anaerobiosis".

In a stab culture of a carbon dioxide producing bacterium the pressure of carbon dioxide will be greater inside the agar gel than on its surface, and it is in some cases feasible that the differences in surface and stab growth are due to these differences in the carbon dioxide pressure. It is easy to demonstrate that this view is correct in the case of propionic acid bacteria: the differences in surface and stab growth disappear when the cultures are kept in an atmosphere containing 5 per cent or more carbon dioxide. Under these conditions the organism grows readily on the surface of agar. Theobald Smith[23] carried out similar experiments on *Brucella abortus* as early as 1924.

The work reviewed in this article shows that carbon dioxide is an active metabolite in heterotrophic cells. It can condense with pyruvic acid to form oxaloacetic acid. By this reaction carbon dioxide is 'assimilated'. Oxaloacetic acid has at least two important functions in cell life; it acts as a hydrogen carrier in the energy-giving processes and is a parent substance of a number of cell constituents. Of special interest is the fact that the condensation of pyruvic acid with carbon dioxide depends on vitamin B_1.

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THE USES OF PSYCHOLOGY IN WAR-TIME

By DR. C. S. MYERS, C.B.E., F.R.S.

PSYCHOLOGY and three of its applied branches —medical, educational and industrial psychology—have made enormous strides since the War of 1914–18. In 1914 these branches were in their infancy; to-day they may be said to have passed their adolescence. Indeed, industrial psychology has so widely developed that the term has become a misnomer. It is now concerned with all occupations, and (in developing vocational guidance) even with pre-occupational life: it should be styled 'occupational psychology'. In 1914 tests of intelligence were only just coming into general use in the medical and educational worlds. Now they are officially recognized by the Ministry of Health, the Board of Education and the Board of Control.

MEDICAL PSYCHOLOGY

In 1914 our present attitude towards the psychoneuroses ('functional' nervous disorders) and their treatment was only just developing. To-day that attitude is approaching stabilization, with maturer experience and the mellowing and blending of certain early crudities of the rival Austrian, French, German and Swiss schools. During the early years of the War of 1914–18 a 'shell-shocked' soldier wandering from his post in a psychoneurotic fugue (or trance) was regarded by Army disciplinarians either as a deserter fit only to be shot for his crime or as a madman certifiable as insane and destined for a lunatic asylum. But by the end of 1916 special hospitals for the reception of cases of war-neurosis and for their psychological treatment by medical specialists had been established in France, both at British bases and in army areas; and similar provision, together with special courses of training for medical officers, was being made at home.

Some of the many lessons learnt have not been forgotten during the present War, although so far the occurrence of war-neuroses has been comparatively rare. To each Army Command throughout Great Britain at the outbreak of war medico-psychological specialists were appointed, acting under a War Office consultant; and a special military hospital was established. A corresponding system was provided for the British Expeditionary Force, and by the Ministry of Health for civilians and soldiers. Intelligence tests, administered by psychologists, are now being officially employed to prevent the retention of men suffering from, or near the border-line of, mental deficiency. The recruitment of men so dull as to make it difficult for them to become satisfactory soldiers has always been a serious problem in war-time. It is especially grave to-day with the increased pace of modern warfare and with the greater skill demanded by a mechanized army. Advice has also been sought by the Admiralty from psychologists during the present War on the improvement of methods for the rejection of the colour-blind.

AVIATION PROBLEMS

The psychological laboratories of two British universities are now engaged in research on individual differences in the speed and degree of adaptation of the eye to darkness—a problem of especial concern to the Royal Air Force. For the same fighting service research is also being conducted on other psychological problems of flying, for example, on the kinds of error to which the pilot is most liable when subject to the stress and fatigue occasioned by prolonged periods of flying 'blind'. Other experiments having a war-time reference are also being carried out in psychological laboratories, for example, concerning methods of communication and concerning the effects of certain drugs and other chemical substances on mental efficiency.

VOCATIONAL GUIDANCE AND SELECTION

I well remember visiting one of our most distinguished mathematicians during the last War at Boulogne in 1915. I found him sorting and counting railway tickets in a small cabin in the marshalling yard of the harbour station! It took some time before his outstanding abilities were utilized in solving the problem of gunnery range-finding. To-day more systematic efforts are being made to avoid such errors of placement. All three of our fighting services are beginning to avail themselves of the psychological principles and methods of vocational guidance and selection which have been developed with increasing success during the past twenty years in choosing the best job for a given applicant and in choosing the best applicant for a given job. Throughout the various commands, army officers are now being trained by civilian psychologists in the application of some of these methods to recruits, so as to help in their selection for commissioned and non-commissioned rank and for special work (for example, driving or gunnery), and to reveal recruits of very low intelligence, within the various arms to which they have already been allocated. This scheme may be usefully extended to recruits *before* their allocation, to men, no longer recruits, who need

transfer from work (for example, tank or pioneer) to which they have already been unsuitably allocated, and to the better selection and allocation of officers. To improve present methods, the War Office has recently appointed a small advisory committee of psychologists. The Royal Air Force is, correspondingly, employing civilian psychologists with the object of sorting out recruits already allocated to its air-staff; the psychological problems of selection of its ground-staff have as yet scarcely been touched. Tests have also been applied to naval units, and the Admiralty has lately invited a vocational psychologist to survey and to report on its present methods of education.

Several local investigations of a less official and less centralized character have also been carried out by psychologists at the request of army officers specially interested in the grading of recruits and their distribution to specialized work. For example, tests have been devised on behalf of a tank brigade for gunnery and for driving efficiency. The commander of an artillery regiment has invited psychologists to test the intelligence of his recruits, and has used the results to help in selecting such specialists as gun position officers' assistants, range-takers, etc. The intelligence has been tested of large batches of recruits in the Royal Army Medical Corps, whose scores were found to range from 0 to 94 (the maximum possible score being 100); the object of this inquiry being to assist in the classification of recruits and in their selection for special duties demanding a fairly high level of intelligence, including the work of instructors and of non-commissioned officers, and, in the case of the most 'backward' recruits, for an appropriate course of special instruction. At the request of a War Office directorate, the best methods of choosing instructors in a certain kind of technical work have been psychologically investigated; and certain recommendations have been adopted. All such work should lend no support to the current popular fallacy that the psychological methods employed in vocational guidance and selection consist solely in the application of tests. These are, in fact, merely accessories to other systematic methods based on psychological principles. They are invaluable servants, but must never be the masters, of the vocational psychologist.

Training

During recent years the attention of certain industrial psychologists in Great Britain has been directed to improvements in methods of training. In most factories the novice has hitherto learnt his job and still learns it by passively watching a more expert operative, by listening to such words of explanation and advice as the latter may be willing or able to give while engaged on ordinary production work, and by 'trial and error' during subsequent routine practice. But the industrial psychologist now insists that training must be isolated as far as possible from production; that a 'school' for novices must be separately established; that the instructor must be most carefully selected; and that the course of training must be systematically planned. He urges this procedure because the expert operative cannot teach satisfactorily while busily engaged on production, and because he often proves a bad teacher, unable to describe what movements he uses or why he uses them, or even believing that he employs certain movements whereas actually he employs others. For the course of systematic instruction installed by the industrial psychologist, the easiest movements and the most advantageous position of parts and tools must have been previously determined. These are demonstrated and taught to the novice, and the reasons for adopting them must be carefully explained to him. As a beginner, he is taught always to inspect his products; and a 'museum of faults' is placed on exhibition, from which he may learn what errors he is likely to commit, how they may be avoided and how, if they do occur, they may best be dealt with.

These new methods of instruction have produced surprisingly good results. Not only have they enormously shortened the period of training, but they have also vastly improved the efficiency of the novices thus trained. They have proved of especial industrial value in war-time, when, as in many engineering works, unskilled persons are necessarily being engaged to take the place of semi-skilled workers who have had to be transferred to more highly skilled work. With appropriate modifications they appear to be also applicable to certain kinds of military training. But so far, in this connexion, during the present War, psychologists have been mainly employed by the fighting services in devising apparatus which will improve and facilitate training, and in addressing officers on the general principles of the subject, at training centres. Books and articles have also been published on the psychological factors involved in leadership, in propaganda work and in the causation of war.

Working Conditions

Industrial psychology has afforded valuable help to firms engaged on Government contracts, in regard to the arrangement of shifts and the distribution of hours of work and rest-pauses, especially when, at the outset of war, excessive working hours were being urged. It has also helped to solve the difficulties of factory lighting and ventilation caused by the 'black-out', which

resulted in unusual fatigue, absenteeism and higher labour turnover. For the Red Cross Society and Order of St. John of Jerusalem, an investigation in industrial psychology has been conducted into the easier packing and handling of parcels destined for prisoners of war.

SOCIAL CONDITIONS

Several systematic studies have been and are being conducted by educational and social psychologists on the effects on children of evacuation and air-raids; and other psychological investigations of similar, but wider, social import, under the ægis of one of the Ministries, can be reported.

This account does not by any means exhaust all the services that psychology is giving during the War. But it may serve to show the growing and increasingly recognized military, medical and social, practical value of the subject.

LA SOCIÉTE DE PHYSIQUE ET D'HISTOIRE NATURELLE DE GENÈVE

BY PROF. F. E. WEISS, F.R.S.

GENEVA has long been renowned as the home of eminent men of science. Some of these, the de Saussures and the de Candolles, belonged to families which, like the Darwins, have produced several generations of distinguished scientific men. It is no wonder, therefore, that the Physical and Natural History Society of Geneva has a deservedly high reputation, and that its *Memoirs* find a ready exchange with the publications of most learned societies. Last October the Society celebrated its hundred and fiftieth anniversary, and an account of the meeting of celebration fills the pages of the October number of its proceedings. The centenary celebration in 1890 was naturally made a great occasion and the centenary volume of the *Memoirs* of the Society contains a number of important scientific papers, as well as a history of the Society prepared by the secretary, Dr. A. H. Wartmann.

Like many learned societies, it had its origin in the desire of a number of men of various professions, but all interested in scientific discoveries, to meet and talk over their observations and theories. They met at first informally and probably at irregular intervals in each other's homes, and their number was for this reason naturally limited. For this reason also there seems to have been some doubt as to the exact time when the Society was founded. It really grew into existence. The first minutes of a meeting are dated August 5, 1791, but M. Vaucher, one of the originators of the Society, gives the date of its foundation as 1790, and this date has been by common consent accepted. No doubt even before that date the Society had an informal existence, for it possesses a manuscript which is said to have been read at one of its meetings in 1783. From the first minutes of a meeting mentioned above we learn that it met in the house of a M. H. A. Gosse, a pharmacist, and a laureate of the Paris Academy of Sciences. Among those present were L. Jurine, a surgeon and naturalist; J. Tallot, whose interests were geological; Pastor Jean Pierre Vaucher, head of a boarding-school and an eminent botanist, interested in freshwater Algæ, one of the most well-known of which has since been named after him. Other members who formed the nucleus of the Society, but who were absent from this first meeting, were M. A. Pictet, a lawyer and professor of philosophy, interested in physics and the applied sciences; Colladon, a pharmaceutical chemist, and the botanist Gaudy. This group of young amateurs, as Vaucher called them, was soon joined by other members of senior standing and already distinguished in various branches of science. They included H. B. de Saussure and his son Theodore, François Huber, well known for his researches on the life of bees, Pyramus de Candolle, the eminent botanist, and Henri Boissier, rector of the Academy and in charge of the instruction in applied botany. His natural history collection became the nucleus of the future National History Museum of Geneva.

It was decided to ask the veteran Charles Bonnet, then seventy-one years old, to become the honorary patron of the Society. This for reasons of health he refused. Being further pressed he accepted the position, but he died two years later, leaving a bequest to the Society.

Ordinary meetings of the Society still remained somewhat informal. The host at whose house the meeting was held presided and read a paper which was followed by a general discussion. Observations published in scientific journals were also discussed by the meeting. One of the original members tells us that the discussions were always amicable and that contributions by young members were welcomed and encouraged. Occasionally

eminent men of science passing through Geneva were invited to the meetings. Such guests included Volta, Berthollet, Arago, Ampère, and others.

The strict religious tenets of the citizens of Geneva are reflected in the rules of the Society, one of which forbade any member or correspondent to admit publicly any religious principles that were not based on theism. Consequently the motto chosen for the Society was "Pro Deo et Natura".

In the early days of the Society—1792–1798—Geneva passed through stormy times, including a reign of terror in 1793 and ending in the annexation of Geneva by France in 1798. Except for an interruption of a few months in 1793, the Society continued its meetings, though they were occasionally prevented by untoward circumstances. When, after the restoration of Geneva to Switzerland, Pyramus de Candolle returned in 1817 as professor of natural history, he found the Society somewhat somnolent. He urged the institution of fortnightly instead of monthly meetings, and advised that the latter should be held in the lecture hall of the Society of Arts. This was done, and shortly afterwards it was decided to publish the *Memoirs* presented to the meetings, and up to date forty-one volumes have appeared containing 435 memoirs.

In 1890, when the centenary celebration of the Society took place; it numbered 450 ordinary and 50 honorary members. The celebrations of the hundred and fiftieth anniversary which took place in October of last year, are described in a special number of the *Compte Rendu* of its meetings. They took place in the large hall of the Athenæum in the presence of some three hundred members, friends, and delegates from kindred Swiss societies. As the president, Mr. Revilliod, said in his opening address, with so much sorrow and misery in the world at large this was not the time to have great festivities, but it was deemed right to have a special meeting of the Society to remember the early days of its birth and growth and to honour its founders and the great men who contributed to its progress and prestige.

The subsequent speakers at the meeting included the Swiss Councillor for Public Instruction, the Rector of the University of Geneva, who dwelt on the close connexion between the University and the Society. This was emphasized by the subsequent addresses, in which three of the University professors dealt with the advances made in various sciences since the centenary celebrations of 1890. Prof. Weigel spoke of the progress achieved during the last fifty years in mathematics and physics. In connexion with the latter subject he dwelt on the important work done by Edward Sarasin and de la Rive in demonstrating the existence and the propagation of electromagnetic waves in space. The advances made by chemical researches in Geneva since 1890 were dealt with by Prof. Briner, while Prof. Fernand Chodat devoted his address to the progress of the biological sciences during the last fifty years.

The list of ordinary and honorary members of the Society elected between 1790 and 1940 follows the account of the meeting, and among the honorary members are the names of many British men of science, including Sir Joseph Hooker, Sir William Ramsay, Douglas Freshfield, and Sir Arthur Eddington.

OBITUARIES

The Right Hon. Lord Stamp, G.C.B., G.B.E., F.B.A.

LORD STAMP, Lady Stamp and the Hon. Wilfred Stamp were killed in a recent air attack on London. Lord Stamp was a man of whom many different obituary notices might be written. As a Civil Servant, as a business administrator, as a Government advisor and negotiator, as a writer on economic problems, he had so many achievements of distinction to his credit that adequate note of him in any one field crowds out reference to any other field. He worked as easily as ordinary mortals breathe or sleep. He could afford to say "yes" to innumerable invitations to speak or write on relatively unimportant occasions without losing power to do first-rate work on important occasions. His energy was incredible and his output superhuman. All this has been emphasized in one way or another by those who have paid tribute to his memory.

The branch of activity in which I came to know him best was different from any of those which I have named above. It was his activity in developing both the teaching of economics and research in it by others. In that field I learned what I believe to have been the central secret of his success and his public service.

Stamp was easily the most distinguished student produced by the London School of Economics and Political Science. He repaid his debt to the School many times over by the services which he rendered on the governing body from 1925, as vice-chairman of the governors from 1930 and, after the death of Sir Arthur Steel-Maitland in 1935, as chairman. In those positions his capacity and his prestige were of enormous assistance to an institution in a state of perpetual growth to meet an apparently inexhaustible demand. Growth implied both an external need for

resources to feed it, and an internal need for adjustments to the changed scale and kind of activities. In solving the innumerable problems, external and internal, incidental to such growth and change, it was invaluable to have at hand a man of Stamp's humanity, justice and breadth of understanding. I remember well more than one question of policy or of important personal choice on which the power to rely upon him to come in and give judgment was of first-rate importance. His handling of problems was so transparently honest and so sympathetic to all the different arguments presented to him, that, however he decided any issue in dispute, those who were unsuccessful went away feeling little less happy than those who had succeeded. They were made able to feel, not that they had had a bad case, but that they had had a good case which had unfortunately encountered a rather better case on the other side. I have often felt, as so many others have felt, that if there was something affecting us which ought to be decided by someone other than ourselves, we would sooner have Stamp decide it than anyone else of our acquaintance. It was this gift of conciliation, of never quarrelling, even in disagreement, that made Stamp seem the indispensable person for so many important tasks of statesmanship and made him perform so well all those varied tasks.

WILLIAM BEVERIDGE.

Prof. Herbert Freundlich, For. Mem. R.S.

BY the death of Herbert Freundlich in Minnesota on March 29 at the age of sixty-one, colloid science has lost one of its chief exponents. His remarkably comprehensive grasp of the literature of what had been up to his time a somewhat widely diffused collection of facts and *ad hoc* hypotheses permitted him to bring them into order and, indeed, into a logical system. His memory will long survive not only on account of his own contributions, but especially for "Kapillarchemie", his classical book on the subject, of which the fourth edition in two volumes appeared in 1930.

There are two predominant characteristics which we associate with Freundlich: the simplicity of his experimental technique, and his great influence as a teacher and inculcator of enthusiasm. It is a remarkable tribute to Freundlich that most of the important monographs on the specialized fields in colloid science which have appeared in the last twenty years have been written by authors who commenced their investigations with him. Whilst it is fairly customary for senior research men to spend some time in foreign universities, the particular piece of research work they carry out there is not often chosen as the main field of their future investigations, yet such was the case in the Dahlem Laboratory.

Freundlich's early work on colloid systems dealt with the preparation and coagulation of sols. Whilst this work covered much the same ground that Sir William Hardy had sketched out some years before, it led Freundlich to a more detailed examination of the various properties which sols can acquire in special circumstances. The general principles of the electric double layer had been laid down by Helmholtz and Smoluchowski: Freundlich was the first to show that the so-called electrokinetic (or Freundlich) potential was an entity distinct from the Nernst or thermodynamic potential, and by a series of important and interesting experiments he showed how variations in the electrokinetic potential and the concomitant change in colloid stability could be produced by the addition of electrolytes. He likewise examined and explained the mechanism of sensitization such as is noted in many biologically important systems and is readily demonstrated by the addition of albumin to a ferric oxide sol.

In 1923 Szegvari showed that a ferric oxide sol to which is added a suitable quantity of electrolyte sets to a gel which can be liquefied by shaking and reverts to a lyogel on standing. This behaviour, termed 'thixotropy', was examined in detail by Freundlich, who showed that the same laws apply to thixotropic setting as in electrolytic coagulation, and that a variety of systems, including a number of great technical importance, such as the paints, can exhibit the phenomenon. In investigations which spread over many years, he showed that thixotropic systems are complementary to the dilatant systems of Osborn Reynolds, with a range of plasticity in between. The investigation of the phenomenon of streaming double refraction shown by sols of anisodimensional particles was another important investigation taken up with all the thoroughness and simplicity of experiment characteristic of Freundlich together with his co-worker, Zocher.

Among many other investigations initiated by Freundlich, the inquiry with Posnjak into the nature of swelling and the investigations on orientated adsorption in relation to catalytic activity must be mentioned as being especially interesting and suggestive. The adsorption isotherm, usually attributed to Freundlich, was in fact proposed and utilized by Boedeker and Wilhelm Ostwald, but Freundlich greatly extended its application, especially to capillary active solutions.

Freundlich was half British by birth; he had many friends both in Great Britain and in the United States. Those of us who knew him well miss a colleague who was not only erudite, but also at the same time both extremely lively and interesting in conversation.

ERIC K. RIDEAL.

I ENTERED Freundlich's laboratory in Braunschweig, where he was professor on the Technische Hochschule, in 1911, working there and later in my own laboratory until the War of 1914–18. Shortly after the War, I translated his great work on colloid chemistry; the second edition, about twice as long, has found no publisher in English. Freundlich in those days was very happily married to a beautiful *Rheinlaenderin* with the dark curly hair and blue eyes of the Celtic type so common in those parts. She was a brilliant pianist, as was Freundlich himself, for he had up to the age of nineteen pursued music as a career with the thoroughness and energy characteristic of his family. When he concluded that he

would never be a great composer, he abandoned music for chemistry, success in anything but creative work being not good enough for him. His father was a Jewish manufacturer, his mother a Scotswoman, and the combination produced five sons of extraordinary but diverse abilities, Erwin, for example, having been the first astronomer to uphold Einstein's views.

The funds available to Freundlich for research were incredibly small—I believe about £60 annually. But he was one of those experimenters able to obtain fundamental results with the simplest means. His laboratory was one more example of the extraordinary fact that important work very frequently comes from badly equipped laboratories. He had an extraordinary aptitude for clearing up, by well-directed experiments linked with a critical examination of other results, groups of phenomena of the complicated type occurring in colloid chemistry. His later work in ultrasonics and thixotropy are examples of this.

Freundlich went to Dahlem in 1917, where for seventeen years he directed a large research school, and spent his happiest and most productive years. He left Germany (as a protest against Nazi interference with his choice of collaborators)—*schlagartig*—using, as he said, the Nazis' own slogan. He went to University College, London, taking his apparatus—a gift of the Rockefeller Foundation. But he was now a different man owing to a domestic bereavement rather than political persecution, which indeed he had only experienced in the persons of his assistants in Dahlem. For this reason, perhaps, his personality was much less appreciated than I had expected.

At the time of his leaving for the United States, Freundlich showed no signs of physical or mental enfeeblement. He is said to have died from a heart-attack, and he never took exercise. But he was a sparely built man, and in the Braunschweig days could walk many a sportsman off his feet when he chose. I sometimes wonder whether he did not take life "to heart" much more than ever he showed, and whether this last exile to an extremely trying climate may not have ended prematurely a life which might now be rendering Great Britain valuable services.

H. STAFFORD HATFIELD.

Prof. E. F. Francis

PROF. E. F. FRANCIS, who died on April 15, was a graduate of Victoria University (Liverpool) and of the University of Erlangen. He joined the staff of the Chemistry Department, University College, Bristol, in 1895, was appointed assistant professor in 1904 and became full professor in 1906. During this early period he played a very active part in the movement which led to the establishment of the University of Bristol, became a member of the first Council and impressed the mark of his personality on the institutions and organization of the new university. He was the second to fill the office of pro-vice-chancellor, which he held until his retirement in 1936, and during the period 1921–22, he was acting vice-chancellor. He became very well known in the city of Bristol and was largely instrumental in promoting the cordial relations which exist between the city and the university.

When he became professor in 1906, he took over the laboratories in the old building facing University Road, with two assistants and fifty students. On his retirement in 1936 the number of students had increased to more than two hundred and the teaching staff included two professors and nine lecturers. In 1908, he was responsible for the building of a new chemistry department, and with the able assistance of Dr. F. W. Rixon he supervised the building and equipment. This Department served as a model for other chemistry departments which were constructed in the years immediately following. He had a great sense of responsibility as to the function of a university professor in the training of the characters of his students. He established a school of physical chemistry at Bristol and with typical unselfishness he encouraged its growth at the expense of his own research school. On his retirement in 1936 his friends collected £2,500 for the endowment of a Francis Francis Scholarship for the encouragement of post-graduate work in chemistry.

Francis's researches, which were carried out in spite of heavy university duties, were very largely the work of his own hands. In some forty original communications to the learned societies, he covered a wide range of subjects in organic chemistry. He was interested in the condensation products between keto-derivatives and substituted anilines, the action of nitrosyl sulphide on organic substances, the catalytic decomposition of nitroso triacetonamine, which he employed for the estimation of hydroxyl ions, and other topics. He was especially interested in the preparation and properties of the long-chain carbon compounds. This interest first arose from his association with Prof. Sydney Young in joint publications in 1898 on the separation and oxidation of hydrocarbons. This led to a more extended research on the oxidation of paraffin wax which has aroused some attention as providing a possible means whereby waxes may be converted into fatty acids and thence to fats. In order to gain accurate knowledge of the materials composing paraffin wax, he studied the systematic building up of the longer hydrocarbon chains ranging from C_{18} to C_{44}. In the course of this work he has cleared up many obscure points in the chemistry of the natural fats and waxes. His advice was frequently sought and ungrudgingly given to other workers in this field. He set a very high standard in the purity of his products; his patience was inexhaustible, and he spared no pains in order to achieve this end. These products were employed in X-ray investigations, in measurements of heats of crystallization, dielectric constants, etc., which researches always received his enthusiastic encouragement. The standard he has set in this field of research will be difficult to surpass, although he was engaged up to within a few days of his death on an investigation which attempted to raise even his own high standards.

W. E. GARNER.

NEWS AND VIEWS

Government Changes

IT was announced on May 1 that the King has been pleased to approve the following appointments: Minister of State, Lord Beaverbrook; Minister of Aircraft Production, Lieut.-Colonel J. T. C. Moore-Brabazon (see NATURE, **146**, 554; 1940: **147**, 344; 1941); Minister of Shipping and Minister of Transport, Mr. F. J. Leathers; Parliamentary Secretary, Ministry of Transport, Colonel J. J. Llewellin; Parliamentary Secretary, Ministry of Aircraft Production, Mr. Frederick Montague. The King has been pleased to approve that the dignity of a barony of the United Kingdom be conferred upon Mr. Leathers, and that Mr. Leathers and Colonel Llewellin be sworn of His Majesty's Most Honourable Privy Council. Mr. R. H. Cross, formerly Minister of Shipping, has been selected to fill the post of High Commissioner in the Commonwealth of Australia for His Majesty's Government in the United Kingdom. It is added that the amalgamation of the two Departments of Shipping and Transport for the purposes of the War will be effected forthwith. The details of this process will be worked out as speedily as possible and when the process is complete the combined Ministry will become the Ministry of War-time Communications.

Social and Technological Change

IN an article "Science in the Totalitarian State" in *Foreign Affairs* of January, W. Kaempffert points out that both Stalin and Hitler agree in requiring the university professor to serve the State, accept the tenets of the official ideology and eschew any excursions into the metaphysical or theoretical. In a totalitarian regime, the artist, man of science or philosopher must not only believe what he is told to believe by his rulers; he must also practise that belief. Objectivity is derided in both the Soviet Union and in Germany as unattainable and as anti-social. This insistence on the crushing of individuality assumes different aspects in the U.S.S.R. and in Germany because of different economic needs and social conditions, but Nazi and Soviet officials and professors go to incredible lengths in following their rules, and the totalitarian concept of the relation of science to the State is remarkably elastic. When political expediency so determines, the whole concept is modified and on the whole the pliancy of the scientific mind in both countries is remarkable.

Behind the ideologies of dictators and professional pliancy, however, Kaempffert suggests that there is more than political expediency, or blind obedience. Dissatisfaction with social structure may also be a factor. If the dictators are to be overthrown and democracy preserved, the part that science and technology have played in the rise of democracy cannot be ignored. Research results not only in change within science itself but also social change. The democratic method is to adapt social change to technological change. The dictators are trying to do the contrary. They have tried to control thinking, above all scientific thinking. Science is more than synthetic dyes or drugs, radio, aeroplanes, television—it is an attitude of mind. If Hitler, Mussolini and Stalin are to rule, the scientific attitude will have to be abandoned when it conflicts with the official social philosophy. If it is abandoned there can be no Newtons, Darwins, Einsteins. Science will be unable to make discoveries which will change the human outlook and with that outlook the social order. To preserve science as a powerful social force for good, the research physicist, chemist or biologist must be permitted to enjoy the fundamental freedom of democracy.

Marxists are right in maintaining that science has never achieved perfect objectivity. But there has been a brave, determined, continuous and on the whole successful effort to strip scientific investigation and theorizing of emotional and of personal predilections. Democracy flounders before it arrives at satisfactory solutions of its social problems, but it is better to flounder and progress than to follow the philosophy of a dictator and remain socially and scientifically static. Under a totalitarian regime science may indeed exist, but it will become frozen as art and science were in ancient Egypt.

The Carnegie Trust

THE thirty-ninth annual report of the Carnegie Trust for the Universities of Scotland covers the year 1939–40, and in addition to an abstract of the financial accounts for the year ending September 30, 1940, includes a summary of grants for the period October 1, 1940—September 30, 1941, reports upon the work of investigators under the research scheme during the year 1939–40, including a list of publications and summary of awards and payments as well as of the awards of fellowship, scholarships and grants under the research scheme, the report of the superintendent of the Laboratory of the Royal College of Physicians for the year 1939–40 with list of publications, and reports upon the work of Carnegie teaching fellows during the academic year 1939–40 with list of publications. Interim distributions for the year 1940–41 amounting to £50,760 have been allocated, or one-fifth of the quinquennial grant, attention being directed to the undesirability of proceeding with extensive building programmes. Of this £8,680 has been distributed to the University of St. Andrews, £13,800 to Glasgow, £9,200 to Aberdeen and £13,780 to Edinburgh with £5,300 to the extra-mural institutions. Of these sums £5,660 is to be expended on libraries, £39,850 for building and permanent equipment, and £5,250 for the endowment of teaching and general purposes.

Up to date, seven fellows and thirty scholars have intimated that their researches have been suspended

on account of war service. Arrangements have again been made to keep the awards open for those now engaged on national duties so as to allow their researches to be resumed at a later date. Further, if a fellow or scholar has undertaken Government work within the universities, he is allowed by the Trust to do so subject to a certificate being obtained from the principal of the university for a fellow or from his supervisor for a scholar to the effect that the work is of that nature. Reference is made to work by Dr. Walter Tebrich under his fellowship in organic chemistry in collaboration with Dr. W. O. Kermack on compounds related to the sulphanilamide drugs, leading to many new pyridine and piperazine derivatives, and on the discovery of new antimalarials, involving syntheses in the benzcarbazole series. In connexion with grants to assist investigations in organic chemistry the report refers to work on derivatives, of acridone related to the sulphanilamide drugs, and to work on the polysaccharides of ribwort seeds and of Irish moss. The report of the superintendent of the Laboratory of the Royal College of Physicians, in addition to further reference to the work of Dr. Tebrich, also refers to other work on antimalarials carried out by Dr. A. P. Weatherhead and by Mr. W. Webster on the synthesis of phenanthroline compounds derived from *m*-phenylenediamine.

Zoos in War-time

THE annual report of the Zoological Society of London, presented at the annual meeting on April 29, shows that, despite a drop of about half the income and attendance figures down to about a third of the normal gate, some two thousand animals have been maintained at Regent's Park, and it is intended to maintain the zoological collection until full activities can be resumed after the War. In 1940 seventy-eight mammals, including an onager, fifty-five birds, and twenty-four reptiles were bred at Regent's Park, and two Rheinhardt's argus pheasants have been reared. Damage from more than 120 fire and explosive bombs has been less than expected, only the rodent house and zebra and wild ass house being seriously damaged, and the young giraffe, 'Boxer', bred at Whipsnade, died of a dilated heart due to over-exertion caused by fright. A few antelopes died of damage caused by fright. Damage to the monkey hill, camel house, ravens' aviary, aquarium and north gate can be made good, while bomb craters at Whipsnade can be relined to serve as dew ponds. The work of the prosectorium is being continued, with the usual examination of blood parasites and bacterial flora, research on the protozoan and helminth parasites of fish, and the routine examination of animals for helminth ova to facilitate preventive measures.

The report of the North of England Zoological Society shows the increasing receipt of animals from other zoos like Bristol, Dudley and Edinburgh to its zoological gardens at Chester for the duration of the War, and of special war-time feeding successes, notably waste chicken heads for leopards and lions, horse-flesh for pelicans, and dried, crumbled stale bread for cranes and pheasants, porridge for sun bears. In the difficulty of losing its male keepers for the services, this Society has had disappointing results from the appointment of girl keepers. The griffin vulture was bred for the first time in Great Britain, and the young bird is now thriving: the adults laid again on March 19.

American Message to British Zoologists

AMERICAN men of science are not forgetful of their colleagues in Great Britain, and many letters expressing interest in conditions in Great Britain tell of the concern they feel. The American Society of Zoologists has expressed its goodwill in the following cablegram, received by the President of the Association of British Zoologists (Prof. J. Ritchie): "The American Society of Zoologists recently in session at Philadelphia sends greetings and encouragement to its British colleagues. L. V. Domm, Secretary". Needless to say, British zoologists warmly appreciate this friendly message, and look forward to a reunion in Great Britain with their American friends when, as J. B. Priestley suggested, the streets shall be blazing with light and all the windows shall be illuminated—but not through the agency of incendiary bombs.

Agricultural Meteorology in India

A FAIRLY detailed account of a year's research work in agricultural meteorology is to be found in the official annual report of the Agricultural Meteorological Section, India Meteorological Department, for the year, 1938–39 (Pp. vi + 48. Simla: Government of India Press, 1940). The Imperial Council of Agricultural Research again financed the section, although proposals for making the Section permanent were under consideration by the Government of India. The Central Agricultural Meteorological Observatory, which is situated in the grounds of the Agricultural College, Poona, extended the scope of its work. This was made possible through the gift of an additional plot of land to the Observatory by the College. Experiments were continued at the Observatory on the rate of ascent of moisture through typical soils and its rate of evaporation from their surfaces. A 30-ft. tower was erected on the new plot for the investigation of variations with height of wind, humidity and temperature. Instrumental development included the design of an instrument for measuring the amount of rain or irrigation water lost by evaporation and by percolation and that actually retained in those layers of the soil with which plants are concerned. A few instruments of this design were made and preliminary trials of them begun.

'Precision' observations for showing the effect of weather on certain crop yields were continued at Poona and Karjat, and trials of statistical methods of sampling for the estimation of crop yields were made. Statistical investigations were also continued of a number of other subjects which have particular importance for agriculture apart from their general

meteorological interest, among them being that of the date and type of the onset of the south-west monsoon along the west coast of India and of the evidence for the influence of afforestation on climate in the Singhbhum District. A notable result of the Section's activity in liaison between meteorology and agriculture can be seen in Appendix I of this report, which is a long list of experimental farms at which meteorological instruments have been installed, with details of each lay-out.

Timber Utilization in Malaya

MALAYAN Forest Records No. 13 (Caxton Press, Ltd., Kuala Lumpur, 1940), by H. E. Desch and A. V. Thomas, is not intended to replace the standard text-books, but to provide local timber users with a minimum of information necessary for the correct use of Malayan timbers under Malayan conditions. The paper, which is fully illustrated, deals with the subject on the well-known lines of: anatomical structure of wood, identification and classification of Malayan timbers, seasoning, defects, preservation, mechanical properties of timber, and design in relation to correct utilization of timber in new buildings. The authors have commenced their work by giving an account of the forest administration, climatic factors, types of forest, timber resources and forest policy of Malaya, sylvicultural operations, timber requirements of the future, exploitation, methods of extraction, and financial aspects—somewhat unusual information to find incorporated in what is admittedly a handbook for timber users. The authors make a noteworthy admission. As a result of their investigations—and they have had predecessors in India—they state that in connexion with the tropical and semi-tropical forests it is not possible to draw a hard-and-fast line between the commercially productive and the protection forests; nor is it possible to calculate with any degree of accuracy the potential annual production of timber to be obtained from these types of virgin forest. The volumes per unit of area obtainable from the latter bear no relation to an equivalent area of commercial forest in temperate regions.

Protection of Buried Electrical Cables

IN the *Bell Laboratories Record* of January, Mr. R. P. Ashbaugh describes how the lead sheath of a buried electric cable can be protected against soil corrosion. These buried cables have been used extensively in rural areas instead of aerial cables for several years. In several localities in the United States, cases have frequently occurred where small rodents such as gophers have gnawed the cables, puncturing the sheath and so letting in moisture, which ruins the insulation. Two layers of substantial steel tape protect the cable conductors against inductive interference from power lines and also against gophers, but they are expensive, and a cheaper construction was therefore sought. The construction adopted consists of a single overlapping layer of impregnated paper, a single layer of thin steel tape applied helically with just sufficient gap to allow for normal bending, a second overlapping layer of impregnated paper, and one or two layers of impregnated jute roving. Floodings of asphalt compounds are applied over the sheath and over each protective layer of paper and jute. About 130 miles of this new construction has been furnished for the buried portion of the Stevens Point - Minneapolis cable, and a considerable number of small orders for territories that are gopher-infested have also been manufactured and installed.

The Stockholm Technical Museum

THE Tekniska Museet of Sweden has recently been installed in new buildings in Stockholm, erected with funds provided by the Knut and Alice Wallemburg Foundation. The Museum was originally opened in 1923, and it has been assisted by many industrial companies and private persons. In view of the important contributions to engineering, metallurgical and chemical progress by many eminent Swedes, the Museum should prove a worthy addition to such institutions. There will be a Hall of Fame and in this will be the busts of Polhem, Swedenborg, Celsius, Ångström, Rinman, John Ericsson, Carlund, Nobel, De Laval, Wenstrom, Brinell and others. An outstanding exhibit is an original tower clockwork shown running, designed and built by Polhem. It was moved to the Museum from St. Mary's Church in Stockholm, where it had been running from 1763 until 1910.

Vital Statistics of London County Council

THE interim report of the London County Council Medical Officer of Health and School Medical Officer for the year 1939 contains the following information. The residential population for the middle of 1939 was 4,013,800, as compared with 4,062,800 at the middle of 1938. The marriages registered in London during 1939 numbered approximately 54,461, or 27·1 persons married per thousand of the population. The live births allocated to London during 1939 were approximately 52,366, as compared with 54,495 in the previous year. The live birth-rate was 13·0 per thousand, the rate for 1938 being 13·4. The deaths in the total population of London during 1939 numbered 46,377, giving a death-rate of 12·3 per thousand, as compared with 11·4 in 1938. Of the total deaths 22,554, or 48·6 per cent, were among females. There was an increase in the number of fatal street accidents—from 363 in 1938 to 519 in 1939. The deaths under one year of age per thousand live births were 47, compared with 57 in the preceding year. This constitutes a new low record.

Dr. Heinrich Kisch

DR. ENOCH HEINRICH KISCH, an eminent balneologist and gynæcologist, was born on May 6, 1841, at Prague, where he received his medical education and qualified in 1862. In the following year he settled in Marienbad as a balneologist, and largely contributed to making that town a health resort. In 1867 he was appointed lecturer, and in 1884 extraordinary professor in balneotherapy, at the medical faculty of Prague. In 1868 he became editor of the *Allgemeine balneologische Zeitschrift*, and later of the *Jahrbücher*

für Balneologie. His principal original works in balneology were "Handbuch der allgemeinen und speciellen Balneotherapie" (third edition, 1875) and "Grundriss der klinischen Balneotherapie" (1897), while his chief gynæcological publications, in order of their appearance, were "Über den Einfluss der Fettleibigkeit auf die weiblichen Sexualorgane"(1873), "Das klimakterische Ältern der Frau" (1874), "Die Sterilität des Weibes" (1895), and "Geschlechtsleben des Weibes in physiologischer, pathologischer und hygienischer Beziehung" (1904), which was translated into English by M. Cedar Paul in 1910 under the title of "The Sexual Life of Woman". An autobiographical work entitled "Erlebtes und Erstrebtes: Erinnerungen" appeared in 1914. He died at Marienbad on August 24, 1918.

Gustave Le Bon

DR. GUSTAVE LE BON, a prominent psychologist, ethnologist and natural philosopher, was born at Nogent Le Notru, Eure-et-Loire, on May 7, 1841. He started his career as a medical officer in the French Army and served in the Franco-Prussian War of 1870–71, but afterwards gave up the practice of medicine and travelled extensively in Europe, Africa and Asia. In 1884 he was ordered by the French Government to report on the Buddhist monuments in India. The results of his investigations were published in "La Civilisation de l'Inde" (1884) and "Les Monuments de l'Inde" (1894). He is best known, however, for his works on psychology, especially "La Psychologie des foules" (1895), which went through twenty-seven editions and was translated into many foreign languages. He also wrote on psychology in relation to the French Revolution, the War of 1914–18, socialism and education. His chief contributions to natural philosophy consisted in his "Évolution de la matière" (1905) and "Évolution des forces" (1907). An anatomical and mathematical study on variations in the size of the cranium won him a prize from the Paris Academy and the Anthropological Society of Paris. He was founder and for some years director of the Bibliothèque de philosophie scientifique. He died on December 14, 1931.

Announcements

PROF. A. V. HILL, M.P., one of the secretaries of the Royal Society, has been elected a foreign associate of the U.S. National Academy of Sciences.

AT a recent meeting of the official and family trustees of the British Museum, Cardinal Hinsley, Archbishop of Westminster, and Sir William Bragg, director of the Royal Institution, were elected to the Trust.

DR. E. L. KENNAWAY, of the Royal Cancer Hospital, London, and Dr. J. W. Cook, regius professor of chemistry in the University of Glasgow, have been awarded the annual Katherine Berkan Judd prize of a thousand dollars by the Memorial Hospital for the Treatment of Cancer and Allied Diseases, for outstanding contributions to the knowledge of the cause and cure of cancer during 1939 and 1940.

A DECREE depriving Mlle. Eve Curie of French citizenship and confiscating her property was signed by Marshal Pétain in Vichy on May 5.

AT the anniversary meeting of the members of the Royal Institution held on May 1, the following officers were elected: *President*, Lord Eustace Percy; *Treasurer*, Sir Robert Robertson; *Secretary*, Major Charles E. S. Phillips.

A NEW institute of hygiene and medical chemistry has recently been established at Göttingen.

AT the recent meeting of the Indian Science Congress at Benares, the Indian Society of Genetics and Plant Breeding was inaugurated. The following officers were elected for the year 1941: *President*, Rao Bahadur T. S. Venkatraman; *Vice-Presidents*, Dr. W. Burns, Mr. K. Ramiah; *Secretary*, Dr. B. P. Pal; *Treasurer*, Dr. S. Ramanujam; *Councillors*, Dr. V. K. Badami, Dr. B. S. Kadam, Dr. J. S. Patel, Dr. T. S. Sabnis. The Society will publish a journal in which papers on genetics, plant breeding and cytology will be published.

A MEETING for the inauguration of a Radiography Group of the Institute of Physics will be held at 6.0 p.m. on May 20, in the Lecture Hall of Messrs. Kodak, Ltd., Harrow. All who are interested in the uses of X-rays in industry, whether members of the Institute of Physics or not, are invited to attend.

THE following awards for 1940 of the Institution of Mining and Metallurgy have recently been announced: Consolidated Gold Fields of South Africa Limited Gold Medal to Mr. C. R. Julian for his paper on "Underground Mining at Rio Tinto, Spain"; Consolidated Gold Fields of South Africa Limited Premium of forty guineas conjointly to Mr. J. Spalding and Mr. T. W. Parker for their paper on "Air-Conditioning Plant at the Ooregum Mine-Kolar Gold Field"; William Frecheville Students' Prize of ten guineas conjointly to Mr. J. E. Denyer and Mr. K. C. G. Heath for their paper on "Mining and Milling Tin-Tungsten Ore at Mawchi Mine, Burma". The Council has also elected Mr. H. K. Picard to honorary membership, in recognition of his distinguished services to metallurgy.

MESSRS. CHARLES BAKER, of 244 High Holborn, London, W.C.1, are desirous of making an appeal to readers of NATURE to offer for sale certain apparatus which they are able to release for work of national importance. The whole of the British scientific industry is engaged on the production of apparatus for war purposes, the result being that the supply of instruments required for research, education and routine inspection work is severely limited. The demand for such instruments is constant, and increasing from every quarter, not only from official sources, but also from the industries engaged on work of the greatest importance. The following apparatus is of special interest: microscopes, optical equipment and accessories, telescopes, balances, spectrometers, refractometers, surveying apparatus, slide rules and drawing instruments.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

IN THE PRESENT CIRCUMSTANCES, PROOFS OF "LETTERS" WILL NOT BE SUBMITTED TO CORRESPONDENTS OUTSIDE GREAT BRITAIN.

Physiological Origins of Cellular Potassium

EQUATIONS describing potassium equilibria across cells have been considered in a previous communication[1], and more fully elsewhere[2], with experimental proof of the principles involved with respect to potassium accumulation. Such potassium equilibria are largely conditioned by the nature of the products formed in the cell, especially the phosphate esters, and by the characteristic permeabilities of the membrane. That there is some association of potassium with phosphate is evident if only from an inspection of ash analyses, but the real problem for this special cation accumulation has lain in the manner of its occurrence and physiological significance. With this latter, or functional value, as distinct from mechanism the present communication is concerned.

At the outset we may consider a freely distensile membrane permeable to univalent cations and anions (which latter with plasma external to the cell may be either uni- or divalent, since divalent anions are in negligible quantity).

The following equation then applies (neglecting activity considerations in an initial presentation):

$$\eta/V + \Sigma b_1 + \Sigma d_1 = c, \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where η/V is concentration of indiffusible substances in cell; Σb_1 is concentration of diffusible cations; Σd_1 is concentration of diffusible anions; c is total external concentration; V is volume of cell water, which may be taken as unity for the normal cell condition, so that:

$$\eta = c - (\Sigma b_1 + \Sigma d_1). \quad . \quad . \quad . \quad . \quad (1\alpha)$$

Also,

$$\varepsilon = \Sigma b_1 - \Sigma d_1 \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where ε is the excess of anion over cation equivalents for the indiffusible substances within the cell.

From equations (1α) and (2), and using the Donnan relation, we can write:

$$\eta = c - \sqrt{(\varepsilon^2 + 4\Sigma bd)}, \quad . \quad . \quad . \quad . \quad (3)$$

where Σb and Σd are the concentrations of the diffusible ions external to the membrane.

Considering frog plasma, and expressing concentrations as millimols per litre (and not including in 'c' neutral molecules freely diffusible across the membrane), we have from equation (3):

$$\eta = 230 - \sqrt{\varepsilon^2 + 4 \times 111 \times 108},$$

or when ε is zero

$$\eta = 11.$$

With a pH value necessarily within 7·0 and 8·0 in such a cell, ε for the protein alone will be about 50 or more, and even if this is balanced in part by indiffusible base, this latter will only use up the small available concentration for η. The arrangement would therefore appear to be a very disadvantageous if not an impossible one for the cell, which under the conditions could accumulate no appreciable amount of phosphate esters (and these it may be noted will contribute about double or more their molal values to ε). The position is somewhat worse if the cell membrane be permeable also to divalent cations, and when permeable to cations only and not to anions, or vice versa, no free inorganic cation or anion could be accumulated during the formative period of the cell.

If, however, we consider the cation permeability limited a stage further to exclude sodium but not potassium (while anions up to the level of inorganic phosphate can also pass), then the condition greatly alters to the advantage of the cell. Equation (3) becomes:

$$\eta = 230 - \sqrt{\varepsilon^2 + 4 \times 2{\cdot}6 \times 108};$$

or, when ε is zero:

$$\eta = 197, \text{ instead of the previous } 11,$$

much the greater part of the total concentration being thus available for indiffusible material within the cells.

When the value of ε is 124, as it appears to be in the living muscle, then η is in turn as high as 102, and for the muscle immersed in the cold and sustaining various potassium equilibria, the two values are almost identical at approximately 104 each. It will be seen, therefore, that the arrangement is of the greatest advantage to the cell, securing the balance of protein anion charges as also the charges on the phosphate esters by inorganic cations derived from without, while at the same time securing a wide range of possible concentration for indiffusible molecules or ions.

Such considerations apply not only for plasma, but also for sea-water in contact with cells having distensile membranes. Even for algæ with membranes not freely distensible the selective permeability to potassium still offers the advantage of securing adequate conditions without large internal pressures. For the non-distensile cell membranes of the root or absorbing cells of land plants, we must seek a further explanation. The special permeability could here be regarded as the retention of a condition evolved in a primitive marine environment, but it would seem better to limit the consideration to real advantages. One of these would relate to the pore size, which is less than if sodium ions were allowed through and may help, therefore, in retaining valuable substances within the cell. A more important point is probably the following. The total concentration of potassium in the soil is more constant than sodium and appears to be better adsorbed and held on the surface of soil particles. If the absorption of salts is determined—as we may expect from thermodynamical considerations—by the product of the diffusible cation and anion concentrations, and if in turn the synthetic processes within are dependent on the concentrations—necessarily minute—of nitrate and phosphate ions,

then a greater uniformity of growth and nutrition will be secured when the cation permeability is limited to the potassium level.

EDWARD J. CONWAY.

Department of Biochemistry,
University College,
Dublin.
March 24.

[1] Conway, E. J., NATURE, 144, 709 (1939).
[2] Boyle, P. J., and Conway, E. J., *J. Physiol.* (in the press, 1941).

Effect of X-Rays on the Regeneration of Root Cuttings

ROOT cuttings (thongs) of seakale (*Crambe maritima*) are known to exhibit marked polarity. In a former communication[1] a method was described of producing buds at the morphological base of a thong by periodic decapitation of both apex and base over a period of eight weeks. A working hypothesis, recently elaborated as a result of subsequent experiments[2], was also outlined regarding the correlation between auxin and meristematic activity. It was suggested that relatively low and high concentrations of auxin controlled the formation of bud and root initials respectively.

A recent experiment carried out here with the use of X-rays not only adds support to this hypothesis but has also resulted in the production of buds at the base of a thong within two weeks from treatment.

Skoog[3], irradiating *Avena* coleoptiles and solutions of heteroauxin with X-rays, claimed that the growth-substances involved were inactivated. Since the seakale root contains auxin[2], thongs were subjected to X-rays with the intention of reducing the total amount of growth-substance in the tissues and thus preventing, as a result of polar transport, the presence of a relatively high concentration at the base.

New thongs, 8 cm. long, cut transversely at each end were used. The parts of the thong treated with X-rays were as follows: (1) upper 3 cm. of the thong; (2) lower 3 cm.; (3) whole 8 cm. Each treatment was divided into three lots and irradiated with 1,000, 5,000 and 25,000 r-units respectively. A normal set of thongs was used as a control. Following treatment with X-rays the thongs were incubated in sand at a temperature of 20° C. and afterwards classified according to their appearance after eighteen days.

Control thongs produced buds at the apex and roots at the base (see accompanying figure, C). The dosage of 1,000 r-units had little effect on the regeneration of thongs in all treatments although root production was slightly decreased especially in (3). However, using concentrations of either 5,000 or 25,000 r-units, thongs receiving irradiation on the upper half produced buds at the base whilst their corresponding apices were inactivated (A); those irradiated on the lower half formed buds apically and remained inactive basally. Thongs given total irradiation remained inactive (B).

A *B* *C*

A, buds basally, apex inactivated. *B*, ends inactivated. *C*, normal thong.

From these results, it appears probable that there is a critical dosage which could be given to the middle regions of the thong for the purpose of partially destroying the auxin supply and thus eventually causing the formation of buds at both ends. Further experiments will be carried out to verify this point.

I am indebted to Prof. R. H. Stoughton for the supervision of this work and also to Metropolitan-Vickers Electrical Co., Ltd., who kindly consented to carry out the X-ray irradiation of the seakale thongs.

WM. PLANT.

Department of Horticulture,
University of Reading.

[1] Stoughton, R. H., and Plant, W., NATURE, 142, 293 (1938).
[2] Plant, W., *Annals of Bot.*, N.S., 4, 607–616 (1940).
[3] Skoog, F., *Science*, 79, 256 (1934).

Ovarian Damage in Mature Baboons produced by Progesterone and Œstradiol Benzoate

IT has been repeatedly shown[1] that the administration of progesterone in amounts of 15–20 mgm. to normal adult baboons in the first part of the cycle (eighth–tenth day) will cause the turgescent perineum to undergo deturgescence, and premature bleeding supervenes within 5–8 days of the last injection. Any quantity of progesterone more than 3 mgm. and less than 15 mgm. will only cause perineal deturgescence.

Examination of the ovaries of baboons treated in this fashion surprisingly reveals the development in one ovary of one or two follicular cysts which may be four times the size of a normal ovary.

Cystic ovaries therefore have been induced in primates by a hormone other than A.P. or A.P.L. substances.

The administration of a single injection of 0·5–5·0 mgm. œstradiol benzoate to baboons in the first part of the cycle will also cause perineal deturgescence which lasts 12–16 days instead of 5–8 days as after progesterone. The experimental cycle is prolonged by 18 days, that is, menstrual bleeding occurs on the fifty-sixth day instead of the usual thirty-eighth. Both ovaries of such œstrogen-treated baboons show degeneration of the stratum granulosum of all the follicles which contain follicular fluid.

If œstradiol benzoate is given daily to baboons from the eighth day of the cycle, then the perineum continues to rise and may be maintained in a state of turgescence for as long as the injections are continued. The ovaries display massive atresia of follicles and there remain only a few apparently unaffected fluid-containing follicles.

If both œstradiol benzoate (1 mgm.) and progesterone (5 mgm.) are simultaneously administered

on the eighth day of the cycle the perineum undergoes deturgescence. A large cyst is produced in one ovary and massive atresia of follicles in both.

The second or third cycle succeeding those which were disturbed experimentally may not deviate very much from the normal.

Œstradiol benzoate, progesterone or a combination of both hormones given to normal adult baboons in the first part of the cycle causes widespread ovarian damage, albeit, perhaps, of a temporary nature.

JOSEPH GILLMAN.

Department of Anatomy,
University of the Witwatersrand,
Johannesburg.
March 21.

[1] Gillman, Joseph, *Endocrinology*, **26**, 80, 434 (1940).

Time as an Imaginary Fourth Dimension of Space is Incoherent

IT may be profitable in relation to current paradox to inquire very briefly into the relation of time to space. Consider two adjacent localities, one around a centre P and the other around a centre Q. The familiar conical diagram asserts that for any sub-locality that is within a certain cone centring on P the relative time is real, while outside that cone it is pure imaginary; and likewise for a cone centring on Q. These cones intersect: and there are regions R, inside one of them and outside the other, for which time is real in relation to P and imaginary in relation to Q, or, in current language, the region around R is time-like in relation to P but space-like in relation to Q. This is something far more complex than the properties of a simple continuum such as a practicable space.

The paradox here suggested may be traced back into the ultimate foundations. The doctrine of the Principle of Special Relativity has been condensed into the slogan that "Henceforth Time and Space are no more". The mathematical Theory of General Relativity has been built up around the postulate (memoir of 1916, English edition, § 3, p. 117) that "the general laws of nature are to be expressed by equations which hold good for all systems of co-ordinates, that is, are covariant with respect to any substitutions whatever (generally covariant)".

The present critique has been stimulated by the observational result that the vast universe of the spiral nebulæ may be in a state of uniform expansion[1], for this suggests the question to determine the formulæ which express that expansion, as the formulæ of the Lorentz transformation express a uniform motion of translation. To my surprise, there appears to be no such set of formulæ. Thus permanent uniform expansion is impossible, so that in the course of time this expanding universe will cease to be uniform; which, by the way, is an alternative mode of accounting for the actual defect from uniformity that has been recently announced. But much more than this, the restriction of permanent uniformity to uniform translatory motion of the frame of reference carries us 'back to Newton', as the phrase goes, and may be even held to provide the explanation of this restricted indeterminacy of his frame of reference in space and time.

All such restrictions appear to be in flat contradiction to the postulate quoted above of General Relativity. The explanation is perhaps not far to seek: for if there is no longer time or space, there cannot any longer be velocity as the mode of expressing motion. But the formulæ here sought, and relations expressed in terms of them, would involve the velocity of one frame of reference relative to the other. Therefore such relations could not express laws of Nature: and these laws would have to be reformulated in terms of variables which probably have no intuitive relation to knowledge based on observation as given by our actual senses. The purely mathematical constructs of Ricci, now named tensors, are perhaps intended to be the foundation of a (very limited) formal universe expressed by variables of this kind. Meantime, the present astronomy, the queen of the mathematical sciences, would remain provisionally.

The reply to this critique might be to ask what is the alternative. For the tensor theory has led to a few results, of extremely special type, some of which have been in part confirmed. An answer appears to be that the tensor theory is far too wide a frame for the actual universe of Nature, which involves six freedoms, three for position and three for motion, whereas the tensor framework works with ten variables (potentials), so that the universe of Nature would have room, so to say, to rattle about in it, while as regards some of the specially simple test questions that are practicable the four extra variables may not come into play.

There can be a further claim, that a systematic doctrine of a duly restricted progress of dynamical Action of the system in time, can profitably absorb the valuable elements of these theories which are a natural general foundation for physics, and of the wave-mechanical as well, by going back a century to utilize W. R. Hamilton's procedures.

JOSEPH LARMOR.

Holywood,
Northern Ireland.
April 7.

[1] NATURE, **147**, 175 (1941).

Malaria in War

WITH reference to the interesting paper on malaria by Dr. V. B. Wigglesworth in NATURE of April 12, p. 436, I offer a short account of the methods used at Taranto during the War of 1914–18.

In 1917 the lines of communication for Salonika, etc., were taken through France and Italy to Taranto. In that year the rest camp at Taranto was hurriedly organized and with some 60,000 men passing through there were some 600 cases of malaria. In the winter of 1917–18 it was decided to deal with mosquitoes there; and to deal with all swamps, etc., within 2,000 yards of the camp. Colonel Robertson, R.A.M.C., was our expert, with great experience in India, of such work.

As Director of Works, Italy, I wired to the Director of Works, France, "Send me your best Land Drainage expert for Taranto." He replied, "You have got him—try Kenworthy" (who was then in charge of R.E. Stores at the base). Major Kenworthy in civil life was a land drainage consulting engineer.

Kenworthy with his experienced eye at once saw that excellent work had been done by the Italians; but that owing to a technical omission the ditches had been allowed to relapse. So he cleaned them of growths; and dug a smaller trench at the bottom of small section to deal with low-water flow and

maintain sufficient velocity, while the old ditches dealt with floods. Some tile drainage was required also. Various farms had wells with buckets which were good breeding places. However, the farmers were pleased to have them sealed when Kenworthy gave them good pumps to replace the buckets. Hollow places in the olive trees were filled with mud. A few puddles after rain required attention. Robertson kept a small squad of men catching mosquitoes with butterfly nets. He plotted the catches on a large-scale plan, disregarding sporadic ones; so that when groups of mosquitoes were shown, an examination would reveal some hollow tree missed or something else easily put right.

The cost was £4,000, whereas I had been expecting ten times that sum. About the same cost was incurred in fitting wire gauze to the huts, which in this case proved unnecessary. As a result in 1918, with some 120,000 men passing through, we had only five cases of malaria. Of these, three were men who went out of bounds (one was a man sent out of bounds on duty), and one was unexplained. I suppose that cases of malaria returning from Salonika were not counted.

The inference seems to be: take a good malariologist, a good land drainage engineer and give them a free hand.

G. E. SMITH.

Hilltop Guest House,
Brenchley,
Kent.

Colchicine-induced Tetraploids obtained from Plants of Economic Value

FROM the work of Kostoff[1] and others we have learned that length and number of the chromosomes are decisive in determining the value of derived tetraploids. Long chromosomes diminish fertility much more than short ones do. The greater their number, the lesser their viability. In consequence one has to choose from plants possessing a reduced number of chromosomes of moderate length.

Furthermore the purpose for which the plants are grown must be taken into consideration. After doubling the chromosome number, tobacco plants will lose their subtle properties of quality almost immediately. Tetraploid fibre-plants, however, may greatly augment the yield. We should therefore consider, whether the important properties are of a quantitative or qualitative nature.

Another fact must be remembered, namely, that creating a tetraploid means producing a completely new biological system. Finally, the action of colchicine may bring forth structural and numerical changes, chromosome breakages, etc., providing a new basis for unbalanced chromosome complements, variability and sterility.

The above-mentioned points were studies on tetraploid *Nicotiana tabacum* L. (Vorstenlanden and Virginia tobacco) and tetraploid *Hibiscus cannabinus* L. (Java jute, Ambari hemp, Decan hemp, Bimlipatam jute).

Tetraploid tobacco was obtained as usual and without difficulty by seed treatment. First of all it was noticed that the tetraploid strains still could be recognized by constant characters, although the general properties had been greatly altered. All tetraploid tobacco plants were smaller than the original diploids. This is in accordance with the large number of comparatively long chromosomes ($2n = 48$) tobacco possesses.

As the enlarged cells contain more chloroplasts, which have not increased in volume, the leaves are darker green. We can assume the production of carbohydrates per unit of leaf surface to be stimulated. This is of interest in the case of Virginia tobacco, the sugar content of which plays an important part in estimations of quality.

The increased leaf thickness makes it possible to produce cigarette tobacco with more 'body', although too thick a leaf may involve difficulties during the process of 'flue curing'. The fine quality of cigar tobacco is completely spoiled by the coarseness of the tetraploid leaf. Moreover the latter is supported by a very irregularly developed framework of veins.

However, here we have to recognize a difference between the primary and the secondary colchicine effects[2]. In most cases the properties of tetraploid plants, grown from treated seeds, are unfavourable, although the Virginia leaf sometimes showed good structure and shape. Diploid tobacco already being a multiple tetraploid, we find a great variability among the offspring of the tetraploids. Most of the plants still closely resemble the mother plant, but some of them tend to improved leaf structure.

Tetraploid Virginia tobacco differed from tetraploid Vorstenlanden tobacco in two other points: the percentage of pollen sterility of the former was higher, while its root tips (so far as I could examine them) contained the diploid number of chromosomes. In root tips of cigar tobacco I always counted about 96 chromosomes.

Many aberrations of merely theoretical interest in the structure of flowers and leaves were found.

A new fact is the occurrence of a number of somatic gene mutations, some of which may obtain practical importance. Their progeny will be examined in order to test the quality.

Tetraploid plants from Java jute (a fibre-plant) were obtained with some difficulty by treating apical meristems with colchicine solution or with the emulsion prescribed by Warmke and Blakeslee[3].

Hibiscus cannabinus is more resistant to diseases as compared with *H. Sabdariffa* (Rosella). On Java the latter is cultivated because the yield is higher. Tetraploid Java jute may combine higher yield with greater resistance.

In this case the chromosomes are small and the cells only contain a moderate number of them ($2n = 36$). Therefore we do not expect very pronounced differences between the diploids and the tetraploids. The experimental results confirm the expectation.

Marked differences in rate of growth, which are characteristic of tobacco, are not observed. In this respect cultivation of the tetraploids meets with no difficulties. Furthermore diploid and tetraploid types closely resemble each other.

The tetraploids may be distinguished by the following characteristics. The plants are ramified to a lesser degree, the leaves show a strong tendency to remain undivided. The tetraploids also show stiff, dark green and thick leaves, broad petals, a strongly developed epicalyx, a high percentage of pollen sterility, stomata with larger diameter, big seeds. In cross-sections of root tips, 72 chromosomes could be counted.

N. P. BADENHUIZEN.

Proefstation voor Vorstenlandsche Tabak,
Klaten, Java,
Netherlands East Indies.

[1] *Chron. Bot.*, **5**, 17 (1939).
[2] Cf. Blakeslee, *Amer. J. Bot.*, **26**, 163 (1939).
[3] *J. Hered.*, **30**, 419 (1939).

RESEARCH ITEMS

Genetical Calculations

I. M. H. ETHERINGTON (*Proc. Roy. Soc. Edin.*, B, **61**, 24–42; 1941) shows that a linear algebra may be constructed which corresponds to genetical phenomena relating to gametes and zygotes. By using this algebra on the usual genetical symbols of a cross it is possible to alleviate laborious calculations of the results of types of mating and population studies. The author shows that the derived algebra differs from the usual in that $P \times (Q \times R)$ does not equal $(P \times Q) \times R$.

Triploid Newts

R. B. GRIFFITHS (*Genetics*, **26**, 69–88; 1941) has produced triploid and haploid newts by refrigerating eggs at close to 0° C. for about twenty hours after fertilization. Out of 100 eggs raised to swimming larvæ, 80 were triploid, 10 were diploid, and 10 were haploid. Since no triploid larvæ arose from refrigeration delayed half-an-hour after fertilization, it is suggested that the second maturation division is inhibited by refrigeration and the second polar body is retained in the egg. Triploid larvæ have larger nuclei and cells in the epidermis, erythrocytes and other parts, but show no gigantism; the number of cells is fewer than in the diploid. Seventy-five of the triploid larvæ showed normal development and fifteen of these were examined during metamorphosis and found to be female. The haploid larvæ were dwarfed and more or less œdematous.

Genetics of Aquilegia

B. SCHAFER (*J. Gen.*, **41**, 339–348; 1941) has summarized the results of her genetical experiments on *Aquilegia vulgaris*. The allelomorphic genes *Bb* for blue-pink flower colour, *Cc* for tall-compact habit, *Ll* for blue-lilac flowers, and a multiple allelomorph series *A*, *aw*, *a* for fully coloured, white-faced, and completely white flowers were studied. *c*, *l* and *a* form a linkage group with cross-over values of 0·0428, 0·136 for *C*—*l* and *l*—*a* and 0·1523 for *c*—*a*. In one family, complete linkage between double flowers and tall habit was found while in another two families independence was observed. The aberrant results in the first family might be due to an inversion of a chromosome. The interspecific relations of species of Aquilegia are discussed.

Germination of Orchid Seeds under Sterile Conditions

THE possibility of growing orchid seedlings under sterile conditions, once regarded as almost impracticable, has of recent years, in part through the work of Knudson, been carried out so successfully that, in effect, orchid hybridization and subsequent seedling production has become a standardized and very profitable technique, and the work of a few growers is probably still contributing appreciably to British export efforts. But it does not follow that Knudson's claims are as firmly established that, in Nature, the usual fungus symbiont is simply necessary because its digestive activities supply soluble sugars from organic substrates—within or without the seeds. D. G. Downie has recently shown in her careful studies of the germination of the relatively rare British orchid *Goodyera repens* Br. (*Trans. and Proc. Bot. Soc. Edin.*, **33** (1), 36–51; 1940) that the seeds germinate readily under aseptic conditions in the presence of sugar, but not in mineral nutrient solutions over a wide range of *p*H. If the endophytic fungus is present, then no outside source of carbohydrate is necessary to start germination. By a wide range of experiments, she brings much support for Bernhard's classic view of mycorrhizal symbiosis. These views have of recent years been strongly supported by Rayner in Great Britain against the argument of Knudson that sugar and not the symbiont is the necessary factor in germination.

South Atlantic Earthquake of August 28, 1933

THIS is the subject of a most valuable paper by James T. Wilson ("The Love Waves of the South Atlantic Earthquake of 28th August, 1933"; *Bull. Seis. Soc. Amer.*, **30**, No. 3; July 1940). The epicentre of the earthquake, located by Geiger's method, appeared to be lat. 58° 56′ S., long. 24° 54′ W., and the initial time 22h. 19m. 38s. U.T. using Gutenberg and Richter's tables. From a stereographic projection of the initial motion at several stations near the epicentre, it was determined that the earth movement which caused the earthquake was probably a fault striking between N. 33° W. and N. 1° E. and dipping between 63° and 76° to the east, the movement at the time of the earthquake being such that the west side moved north with respect to the east. In studying the seismograms, special reference was paid to the *G* wave portion, which was integrated by means of the mechanical integraph of Prof. L. D. Leet. From the earth motion diagrams so obtained it appears that the waves were Love waves, and that where the paths had been under the ocean almost all the energy was in the first period of the group. Furthermore, to a reasonable approximation, it was considered that on mixed paths all the dispersion took place on the continental part of the path. The amount of dispersion along the oceanic paths was much less than along the mixed paths, and from the data the author points out that there is no reason to assign different crustal structures to the different ocean basins. For example, the data from Ivigtut on an Atlantic path is practically the same as that from Honolulu on a Pacific path, and very similar to that from other stations which are on paths through the Indian Ocean basin. The structure of all the oceans appears to be characterized by having material in which shear waves have a high velocity much nearer the surface than is observed in the continental regions. The thickness of the crustal structure in continental regions, according to the author, appears to be about 30–40 km.

The Melting Range of Fats

A PHOTO-ELECTRIC method for the determination of melting points of fats by which the present lack of consistency between the results of different observers using the capillary tube method may be avoided was described by K. A. Williams at a meeting of the Society of Public Analysts and other Analytical Chemists on February 5. The fact that melting starts at a temperature below the visual melting point is confirmed by a modification of the

dilatometric method which leads to reproducible and definite results for the true incipient and complete melting points. The possible use of figures for change in volume on melting and for the rate of change of density with temperature during melting is suggested as a means of characterizing fats.

Thermodynamic Properties of Propane

RECENT developments in the utilization of propane have revealed the need for more complete information upon its thermodynamic properties. The available physical and thermal data have been summarized and correlated, and some new experimental determinations of pressure-volume-temperature relationships for the liquid at low temperatures have been carried out by J. H. Burgoyne (*Proc. Roy. Soc.*, A, 176, 280–294; 1940) at the Imperial College, London. On the basis of the information thus obtained, the entropy and enthalopy of propane have been calculated for conditions of temperature between −80° and 200° C., and at pressures of from 0·1 to 200 atmos., and are presented in a folding chart with the paper.

Covalent Radii

IN the system of covalent radii developed by Pauling and Huggins the length of a covalent bond is equated to $r_A + r_B$ where r_A and r_B are the covalent radii. For example, in the ethane, chlorine and carbon tetrachloride molecules the bond-lengths are given (in A. units) $r_{C\text{-}C} = 1{\cdot}54 = 0{\cdot}77 + 0{\cdot}77$, $r_{Cl\text{-}Cl} = 1{\cdot}98 = 0{\cdot}99 + 0{\cdot}99$, $r_{C\text{-}Cl} = 1{\cdot}76 = 0{\cdot}77 + 0{\cdot}99$. If the bonds are not single covalent bonds other sets of radii are used. Recent measurements with fluorine, hydrogen peroxide and hydrazine indicate an upward revision of the radii for fluorine, oxygen and nitrogen, and with these revised values many bond-lengths which obeyed the additivity rule with the old values are now significantly less than the sums, while for electronegative pairs (F–O, Cl–O, etc.) the bond-lengths are generally less than or equal to the radius sums, although they are greater than the lengths derived from the old radii. V. Schomaker and D. P. Stevenson (*J. Amer. Chem. Soc.*, 63, 37; 1941) now show that new values of the normal covalent single-bond radii of hydrogen, nitrogen, oxygen and fluorine can be derived which are consistent with the bond-lengths in the hydrogen, hydrazine, hydrogen peroxide and fluorine molecules. The additivity rule for bond-lengths is shown to be no longer generally valid but it can be used with a correction for the ionic character of the bond. The latter involves the so-called electronegativity on the Pauling scale. For many carbon bonds the additivity rule gives better results than the new equation. It is concluded that bond-lengths are affected significantly by even quite small amounts of ionic character.

Asymmetry of Cosmic Radiation at High Latitudes

Two papers on the east–west asymmetry of the cosmic radiation at high latitudes appear in the January number of the *Physical Review*. F. G. P. Seidl (59, 7; 1941) has measured the sea-level east–west asymmetry of unabsorbed cosmic radiation and of that radiation penetrating two thicknesses of lead, 20° from the vertical, at geomagnetic latitude 54° N., well above the 'knee' of the latitude effect. A theoretical treatment is given by T. H. Johnson (59, 11; 1941). The slight east–west asymmetry of the cosmic radiation is interpreted to be the result of the deflection by the earth's magnetic field of the mesotron component while the rays are losing energy by ionization in the atmosphere. Since this component contains about 20 per cent more positive than negative rays, these deflections result in an asymmetry. Orbits of rays, including those in the range of energy where rest-mass cannot be neglected, have been investigated, and the deflections without energy loss, namely, those of the primary rays described by the theory of Lemaître and Vallarta, result in a symmetrical distribution for the energy ranges concerned. The asymmetry is traced to the *difference* between the actual deflection and that of a ray which loses no energy. The 'difference' deflection δ shifts the angular distribution so that rays which, in the absence of a field, would have produced an intensity proportional to $\cos^2\zeta$ at zenith angle ζ actually produce this intensity at an angle $\zeta + \delta$. Asymmetries calculated in this way agree with the observed values, and give the correct variation of asymmetry with zenith angle and elevation.

Nature of Solar Hydrogen Vortices

THE cause of the vortex-like markings surrounding sunspots on spectroheliograms taken in the centre of the $H\alpha$ line has long been a vexed question. Two theories have been advanced to account for the patterns observed: first, that they are associated with magnetic fields produced by charged particles whirling below the solar surface; second, that they are true vortices in the hydrodynamical sense. In the January issue of the *Astrophys. J.* (93, 24; 1941), R. S. Richardson examines all Mount Wilson spectroheliograms taken over the period 1908–1939 in an attempt to decide which explanation is the more likely. If the particles partaking in the low-level whirl of the first hypothesis are always of the same sign, all spots with the same polarity should have the same direction of whirl; and when the general reversal of polarity occurs at sunspot minimum there should also be a reversal of direction in the vortices. In fact, however, the tendency is for clockwise whirls to appear in the southern hemisphere, counterclockwise ones in the northern hemisphere, regardless of the polarity of the underlying spot. This result, derived as it is from 141 vortices distributed over three sunspot cycles, seems likely to establish the supremacy of the hydrodynamic theory, namely, that the direction of a hydrogen vortex is determined primarily by the solar rotation, and is not connected with the polarity of the associated sunspot.

Photo-Electric Observations of 12 Lacertæ

H. E. GREEN has published (*Mon. Not. Roy. Astro. Soc.*, 101, 1) results of observations of this star from August 30 to October 29, 1940, with the Sheepshanks Telescope, Cambridge Observatory. No detailed discussion is given as the observations are intended to be combined later with those of Prof. Fath, who carried out similar work over the same period at Lick Observatory. The comparison star was 10 Lacertæ and on some nights control observations were made on 9 Lacertæ; the fourth column of the table gives the differences (9 Lac.–10 Lac.) which should be constant. It is pointed out, however, that these control observations are likely to be much less accurate than those of the variable itself, owing to the greater distance between the stars requiring about ten times the atmospheric extinction corrections.

RADIOACTIVE INDICATORS, ENTERIC COATINGS AND INTESTINAL ABSORPTION

PROF. K. LARK-HOROVITZ AND DR. HERTA R. LENG*
PURDUE UNIVERSITY, LAFAYETTE, INDIANA

CERTAIN medicaments cannot be administered orally without either irritating the stomach tissues or becoming destroyed by the gastric juice. To avoid these effects they are given in pills with enteric coatings. Such coatings are supposed to pass the stomach undissolved and to dissolve only in the small intestines.

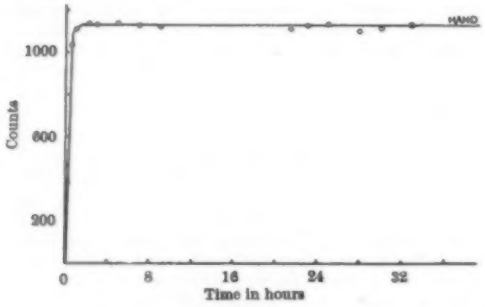

Fig. 1.

UP-TAKE OF RADIOACTIVE SODIUM AS MEASURED BY THE ACTIVITY OF THE HAND. 0·3 GM. Na^*Cl: SODIUM ABSORBED FROM STOMACH.

Since the introduction of enteric coatings by Unna in 1884, various methods have been tried to test their efficacy. In recent years X-ray radiology has been used[1]. The methods used so far do not detect cracks in the coating, which may lead to a leakage and consequently to destruction of the contents by the gastric juice.

Radioactive materials as fillings are obviously admirably suited for such tests. Any crack in the coating is detected at once by the appearance of the radioactive material in the blood-stream as measured by the activity in the hand, and the capsule itself can be easily followed on its way through the digestive tract until it is dissolved. The experimental arrangement, therefore, is the following: Ordinary gelatin capsules are filled with about 0·3 gm. of radioactive sodium chloride obtained by bombardment with 8·5 Mev. deuterons for about 2–6 μ amp.h. The initial activity of the sample is of the order of 500–700 μC. The capsule is coated with a mixture of shellac, castor-oil and alcohol following a formula of Prof. C. O. Lee of the School of Pharmacy, Purdue University. The capsule is administered orally and is followed through the digestive tract with the aid of a movable bell-type counter. Simultaneously, the activity of one hand of the patient is measured to determine the movement when the active material has reached the blood-stream.

Fig. 1 shows the activity as a function of time when the salt has been administered orally without the coating. The first sign of activity in the hand is detected a few minutes after intake; it then increases steadily to reach a constant value in about 3 hours[2].

Fig. 2A shows the location of a coated pill in the digestive tract, throughout the experiment. In this particular case, it is located for about one hour in one position in the stomach; then it moves towards the pylorus and can be located again in the small intestines. After 2½ hr. the movable counter indicates that the pill dissolves and the activity is spread over a large area. Now the activity appears also in the hand, which was, up to this time, entirely inactive.

TABLE 1.

	Total No. of Exp.	Dissolved in Intestines	Dissolved in Stomach	Unknown	Not dissolved
Handcoated pills	21	14 (66 per cent)	2 (10 per cent)	3 (14 (per cent)	2 (10 per cent)
Commercial coatings	10	5 (50 per cent)	4 (40 per cent)	1 (10 per cent)	

Fig. 2B shows the activity in the hand throughout the experiment. The first activity is observed after about 2½ hours, when the pill starts to dissolve; it reaches a maximum after about 8 hours (5½ hours

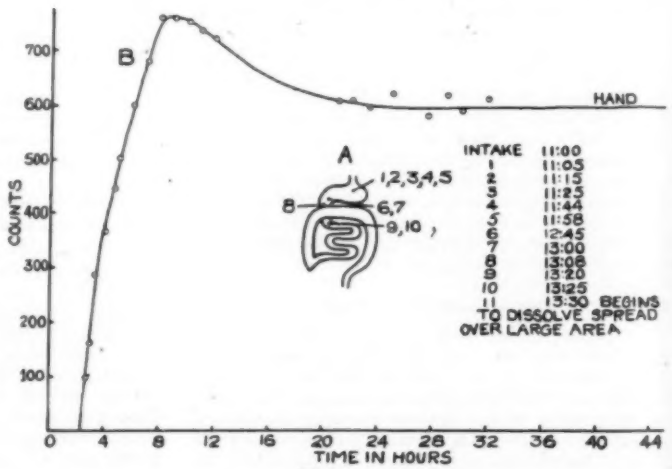

Fig. 2.

UP-TAKE OF RADIOACTIVE SODIUM FROM THE SMALL INTESTINES AS INDICATED BY THE ACTIVITY OF THE HAND. THE POINTS IN THE SCHEMATIC DRAWING *A* ARE, OF COURSE, ONLY APPROXIMATELY LOCATED. 0·3 GM. Na^*Cl IN COATED PILL, DISSOLVED IN SMALL INTESTINES AFTER 2 HR. 20 MIN.

* Aurelia Henry Reinhardt International Fellow of the American Association of University Women.

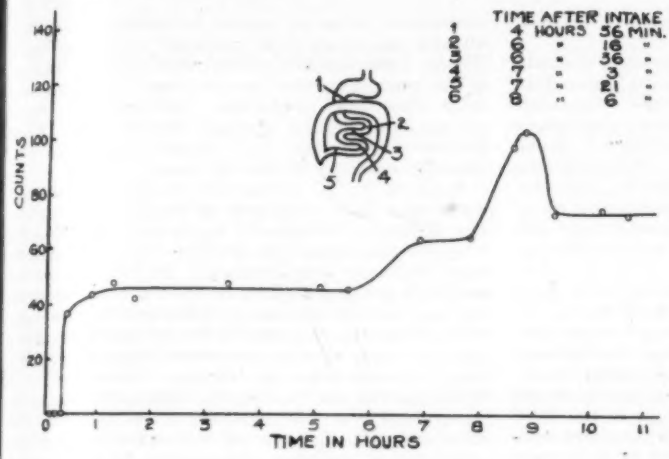

Fig. 3.

UP-TAKE OF RADIOACTIVE SODIUM FROM THE SMALL INTESTINES; THE ENTERIC COATING HAD A LEAK. 0·3 GM. $Na^{\bullet}Cl$ IN ENTERIC COATING DISSOLVED IN SMALL INTESTINE AFTER 8 HR.

after it started to disolve) and then decreases to equilibrium value.

Fig. 3 was obtained with a pill which apparently was leaking, for an activity in the hand can be detected half an hour after intake. The pill itself could be followed for about eight hours, when it finally dissolved in the intestines. At this time the activity in the hand is raised, reaches a maximum in about one hour and falls again to a level higher than the first one, since now the total activity is distributed throughout the body.

Besides the handcoated pills, commercial coatings have been tested. In this case some 100 or 1,000 pills are coated at the same time, and the few active samples can be easily segregated with the aid of a counter.

The results in Table 1 indicate that the majority of the handmade pills dissolve in the small intestines.

In connexion with other experiments on the distribution of the sodium, potassium and chlorine ions in the body, we want to direct attention to the fact that the curve for the time-rate of absorption from the stomach is entirely different from the absorption-curve from the small intestines. In the first case the absorption reaches a level which remains constant for hours and decreases only after a large amount of the salt has been excreted. The absorption from the intestines raises the salt level temporarily and equilibrium is reached through back-diffusion, indicating that a local surplus produced by a sudden release of salt causes a real absorption through the wall of the intestines which is adjusted later by back diffusion and ionic exchange.

A detailed description of these experiments will be given elsewhere.

[1] Corley, J. T., and Lee, C. O., *J. Amer. Pharm. Assoc.* (5), **27**, 379–384 (1938).
[2] Hamilton, J. G., *Proc. Nat. Acad. Sci.*, **23**, 521 (1937).

WORK OF THE BRITISH EMPIRE CANCER CAMPAIGN

By Dr. E. Boyland

The Chester Beatty Research Institute, The Royal Cancer Hospital (Free), London

THE seventeenth annual report of the British Empire Cancer Campaign contains 280 pages as compared with 368 pages of the previous report. The total sum expended in grants in aid of research amounted to more than £40,000, as compared with £53,000 for the previous year.

Interesting advances into the possible origin of cancer have been made by examining human organs for possible carcinogenic agents. Some years ago, the Russian investigator Schabad prepared carcinogenic material from the liver of a woman dying of cancer of the stomach. Dr. des Ligneris has investigated this problem in South Africa, where cancer of the liver is common among Bantus, but not among Europeans. Extracts of livers from normal Europeans were not carcinogenic, but extracts from the livers of both cancerous and non-cancerous Bantus produced cancer in mice. Dr. I. Hieger is working on the problem in London, and has induced tumours in mice by treatment with the unsaponifiable fractions of livers from European cancerous and Bantu non-cancerous subjects. Several tumours in mice were obtained by treatment with the extract of a liver from a case of lymphosarcoma.

Normal human liver and bile contain deoxycholic acid and, as was reported in these columns (Cook, Kennaway and Kennaway, NATURE, **145**, 627; 1940), this acid is carcinogenic to mice when injected subcutaneously but not when painted on the skin. The carcinogenic material isolated from human livers is not likely to owe its activity to deoxycholic acid, as it is the unsaponifiable fraction which contains the active material.

Carcinogenic hydrocarbons in very low concentration are able to photosensitize Paramecia. Using this as a means of detection, Dr. J. C. Mottram has been able to show that when 3 : 4-benzpyrene is applied to mice, it accumulates in the liver and lungs. This is of interest, as it helps to explain the fact that some carcinogenic compounds induce tumours in these organs in certain strains of mice. The addition of benzpyrene to a culture of Paramecium kept in the dark increases the rate of growth, and after prolonged cultivation in the presence of the hydrocarbon

many abnormal forms are produced (see also NATURE, 145, 184; 1940).

The relationship between carcinogenic action and inhibition of growth with change in chemical structure has been carefully studied and many new compounds have been synthesized. Most carcinogenic compounds inhibit growth, but 9:10-dimethylanthracene, which is a weak carcinogenic agent (and incidentally the simplest known carcinogenic hydrocarbon), does not inhibit growth. Dr. A. Haddow has tested many compounds for growth-inhibitory power, and has found that 1:2′-azonaphthalene inhibits tumour growth without being carcinogenic.

Definite inhibition of tumour growth with three types of compounds has been obtained by Dr. E. Boyland. Of the first group, of aldehydes and their possible metabolism products, citral and malonic acid were the most satisfactory; of the natural bases representing the second group, aminoethylalcohol and cadaverine gave definite results; while of the third group of aromatic diamines, 4:4′-diaminodiphenyl-ether is the most promising. It would be of interest and value to know if some of these substances had any effect on cancer in human beings.

Dr. T. Lumsden, at the London Hospital, has tested the effect of adding normal tissue fragments on the growth of a mouse carcinoma in tissue culture. While pituitary tissue increased the rate of growth, liver fragments inhibited the growth. This latter result is in agreement with the results recently published by Brues, Subbarow and Aub in the United States, who found that the inhibitory effect of liver was in part due to aminoethylalcohol.

Prof. E. C. Dodds has continued his investigations into synthetic œstrogens, and with Dr. S. W. Stroud has studied the metabolism of these compounds in rabbits. Synthetic œstrogens appear to be more stable in the body than the naturally occurring œstrone. It was found that the œstrogenic hydrocarbon stilbene is converted into 4:4′-dihydroxy stilbene, which is much more active œstrogenically than stilbene. Several other related aromatic compounds are also converted into œstrogenic phenols in the body by an analogous change.

Dr. K. J. Bonser and Dr. J. M. Robson have examined the response of male mice of three inbred strains to synthetic œstrogens. In the *R* III strain, 60 per cent of the male mice developed mammary cancer while in two other strains (*C.B.A.* and Strong *A*) no such tumours appeared. In the Strong *A* strain the treatment caused hyperplasia of interstitial cells in the testis and the development of nodules, some of which had the histological characteristics of malignant growths. Dr. P. A. Gorer describes the post-mortem findings in three pure lines of mice. In the *C.B.A.* strain, cancer is found more frequently in males than females, owing to the high incidence of liver tumours in male mice of this line. In the Strong *A* strain, the incidence of mammary tumours is high in breeding females, particularly in animals which have frequent pregnancies but which fail to nurse their young. Mice of the *C* 57 black line are resistant to mammary cancer, but frequently develop lesions in the lymph glands, and leukoses. These differences in the types of cancer which occur in strains are possibly analogous to the differences in the occurrence of cancer in different human races.

Viruses which transmit tumours in fowls continue to be investigated in many laboratories. Dr. P. R. Peacock has compared the properties of filterable and non-filterable tumours. Tumours which can be transmitted from one animal to another by cell-free filtrates are much more resistant to the action of X-rays than tumours which cannot be transmitted in this way. Filterable tumours also remain infective after thorough mechanical disintegration which renders non-filterable tumours non-infective. These results suggest that it is unlikely that the non-filterable tumours contain a virus.

Methods for the purification of the Rous sarcoma virus have been developed by Prof. J. McIntosh at the Middlesex Hospital. By means of a modified Sharples centrifuge, considerable concentration of the virus particles was obtained. Dr. A. Pollard has analysed particles isolated in this way from the Rous sarcoma and other tumours, and also similar preparations of vaccinia virus and bacteriophage. The isolated particles from vaccinia, from the Rous sarcoma and from two non-filterable tumours are all similar in lipoid, protein and phosphorus content. Such tumour concentrates act as antigens when injected into rabbits, but in this reaction it is so far impossible to separate fowl and virus components. In other experiments it was impossible to immunize fowls against fowl tumours.

Dr. L. Hoyle, at Leeds, has examined a number of mouse tumours and extracted a lipoid antigen which does not appear to be present in normal mouse tissues. The same antigen appears to occur in several strains of tumours, but it is not present in all mouse tumours.

In the University of Sheffield Field Laboratory it has been shown that the immunization of rats to a transplantable dibenzanthracene rat sarcoma did not influence the induction of tumours by 1:2:5:6-dibenzanthracene. From this and other experiments it is concluded that no immunity to cancer can be expected using techniques based on the principles of bacterial immunity.

Dr. F. Dickens and Dr. H. Weil Malherbe have found that the metabolism of intestinal mucosa resembles that of tumour tissue. Reference is made to a discussion in NATURE (145, 512, 778; 1940) on the carbohydrate metabolism of tumours. It is now generally agreed that anærobic glycolysis and low respiratory quotient are not specific for cancer tissue.

Dr. C. E. Dukes has made a careful analysis of 1,000 cases of cancer of the rectum, a form of cancer known to be much more common in men than women. Lymphatic metastases from rectal carcinomata occur more frequently in men than in women, and these, along with the most malignant tumours, occur more often in young than elderly patients. On the other hand, the mean age of occurrence was earlier in women than in men.

The Clinical Cancer Research Committee has tabulated data from 7,872 case sheets which were received for the year 1938. Registration of new cases was suspended at the outbreak of war, but the data already available are being examined. It is very unfortunate that on some of the points there is a high percentage of "Not Stated" returns, which makes it impossible to draw definite conclusions from the figures. The suspension of registration of new cases should give opportunity to consider the results so far obtained and possibly to improve the methods of registration that will be used when the War comes to an end.

Although research in certain branches has been much reduced as a result of the War, when one considers the present situation it is gratifying to see that so much progress has been made during the year.

THE ROTHAMSTED FIELD EXPERIMENTS ON THE GROWTH OF WHEAT

By Dr. R. D. Preston
University of Leeds

It is perhaps fortunate that the approaching centenary of the Broadbalk experiment at Rothamsted has stimulated the publication of a detailed report on wheat studies carried out there, at a time when interest is growing rapidly in the question of the relative merits of farmyard and artificial manures. The Broadbalk experiment in particular has continued over a period sufficiently long to detect any progressive deterioration in the crop, resulting from the continuous use of artificial fertilizers. The present report[1] is of particular interest, since it includes not only the continuous wheat experiments themselves, but also a comparison with a variety of rotation experiments and with ordinary farming methods at a variety of stations.

The Broadbalk wheatfield was last year harvested for the ninety-seventh time in succession, and this is the third discussion which has appeared during that time. On the first occasion (1893) the first fifty years were reviewed by Lawes, the founder of Rothamsted, and his collaborator Gilbert, and on the second by A. D. Hall in 1905. Since 1919, the scope of the experiment has been widened considerably, and in particular the application of statistical methods not previously available has enabled much more information to be extracted from the existing data.

The Broadbalk field slopes downward from east to west, and is divided into strips running down the slope, each of which annually receives the same manurial treatment, different from that in other strips. There is no obvious important trend in fertility across the field; the soil is, in fact, everywhere rather poorly adapted to wheat cultivation, as evidenced by the relatively low yield (maximum 55 bushels per acre as against 60 bushels often yielded on farms and one observed yield of 96 bushels). Originally set up to disprove Liebig's theory that plants receive all their nitrogen from the air, many valuable data have been accumulated on the relative effectiveness of farmyard manure and a range of artificial fertilizers. It was early demonstrated that addition of nitrogen to the soil markedly increases the yield of grain and straw (for example, 44 lb. of nitrogen as ammonium sulphate gives an increase of 1 bushel of grain) but that minerals are also necessary. For grain production, sodium nitrate is considerably more effective than ammonium sulphate in a single dressing (43 lb. per acre) but not so much with a double dressing. For straw production sodium nitrate is always decidedly the more effective, and for both straw and grain spring application is preferable to autumn (due probably to less leaching from the soil). Levels of supply well above those in ordinary practice give greater yields. Perhaps the most important point in this connexion is that farmyard manure has only 44 per cent of the efficiency of sodium nitrate, and only 50 per cent of that of ammonium sulphate, when the artificial manures are added with complete minerals. Potassic fertilizers increase the yield both of straw and grain, an effect which is diminished by phosphate deficiency. This higher efficiency of artificial fertilizers does not appear to be offset by any progressive deterioration in the crop. During the period 1852–1918 the annual diminution in yield (eliminating random variations) was certainly lowest with farmyard manure (0·1 per cent of mean yield), but this was closely followed by the plot with complete artificials (0·26 per cent). The highest rate of deterioration was found in the plot receiving nitrogen and PO_4 without potassium, where it amounts to 1 per cent. It is interesting that on the unmanured plot, though yields fell from 20 bushels per acre to 10 in twenty years, they have not fallen lower except when weeds have become prevalent; in fact, during recent years they have risen.

This annual deterioration is attributed largely to changes in soil composition. All the plots with the exception of the farmyard manured have lost carbon and nitrogen compounds, but though the soil in the farmyard manured plots is different from that in others as regards physical properties there is no evidence that this soil is better suited to the wheat plant. There is certainly no suggestion, as the years go by, of progressive injury by rusts or by insect pests, though 'eye spot lodging' is somewhat more common than on crops grown in rotation.

Apart from this slight steady deterioration, the so-called 'annual variations' related to weather conditions, chance variations in cultivation, etc., have also been studied in detail. The main causes of such variations in yield are almost solely connected with weather factors; contrary to general belief time of sowing has no observable effect. The defect of the Rothamsted climate for wheat is that rainfall is much too high. In general it may be said that injury due to rain is least in October and greatest in or about January, when each additional inch of rain reduces the crop by one or two bushels per acre. This effect of winter rainfall is to be attributed partly to a leaching out of nitrogen (and is therefore least marked with farmyard manure), partly to excessive growth of weeds and, at Broadbalk, partly to the already heavy nature of the soil. The rainfall effect accounts for about $\frac{1}{4}$–$\frac{1}{2}$ of the total annual variation on most of the plots, though on the farmyard manured plots the effect covers about 40 per cent of the total and is the most important single factor concerned.

The chief practical difficulty in continuous wheat cultivation is the fight against weeds. The time between harvesting one crop and sowing the next is short and is usually not suited to the effective killing of weeds, and control is complicated by delayed germination of some weed seeds (2–9 years or more). The relation between weed infestation and wheat yield is not simple, but it is proved that wheat is ill fitted to stand up to the competition of weeds. Introduction of a fallow in order to eradicate weeds proved a success. The yield, which had been deteriorating, jumped immediately to the original level; an effect which is perhaps all the more striking as it lasted only one year. The main points about fallowing appear to be (1) that it enables control of weeds to be made and allows the formation of a better seed bed and soil conditions; (2) it allows an

accumulation of nitrogen which may be very considerable (rising in plots with minerals only to the level of one with minerals plus 86 lb. N as ammonium sulphate); (3) it emphasizes the need for potash. Although the effect of a single fallow is so marked, a continuous wheat-fallow rotation commenced in 1856 (Hoos field) showed that the effect does not continue and a prolongation of the fallow to three years (Hoos field, 1932) or four years (Broadbalk, 1930) does not materially increase the yield. As regards the success of the old three-field system, it must be remembered that medieval fallows were never clean fallows; the land was left to natural vegetation and was grazed.

In 1930 an experiment on modern lines was begun at Rothamsted and at Woburn involving a six-course rotation of both crops and treatment. The wheat follows clover, and the yields without added manure are so good that added nitrogenous fertilizers have no effect at either station. Additional potash slightly increases the yield (Rothamsted) or, like phosphates, has no effect. In normal rotation conditions at Rothamsted (the Norfolk rotation—swedes (manured), barley, clover, wheat) begun in 1848 the addition of manure to the swedes had no effect on the wheat for the first twenty years, though afterwards the yields on unmanured land deteriorated more than on the manured. When clover failed it was replaced by beans, and both crops were found better than fallow except on unmanured land. The yields on all plots were similar, and resembled the Broadbalk continuous wheat yields with farmyard manures. In a mangold, barley, beans, wheat rotation (Saxmundham, commenced in 1899), however, the increase in yield with nitrogenous manure is almost the same as on Broadbalk, and here again the effectiveness of farmyard manure is considerably less (30 per cent) than that of sodium nitrate.

An analysis of the development and composition of the wheat plant as affected by fertilizers has produced results of no less interest. Up to a certain point increased nitrogen has no effect on the composition of the wheat plant or on its habit of growth, and this point can be carried to a higher level of nitrogen supply by giving potash and phosphates. Finally, however, a point is reached at which nitrogen is in excess; the leaves become liable to fungus attack, the crop tends to lodge, and the straw remains green for a longer time and dries slowly at harvest. The variation of composition with season is much more marked than with manuring. Milling and baking tests show no significant effect of treatment on quality, and the recent claim that wheat grown with farmyard manure is of better nutritive quality than wheat grown with artificial fertilizers is not supported by the Broadbalk samples as regards vitamin B.[1]

Continuous wheat cultivation has not found favour in England for a variety of reasons. Nevertheless, where a good outlet can be found for the straw, very frequent wheat growing has proved profitable provided the manurial system be sound; it has, in fact, been followed by a number of farmers with success. It is at least quite clear that, should continuous wheat growing be taken up in England, these experiments at Rothamsted will prove of inestimable value. On one point they are especially conclusive. No amount of manuring and no elaborate care in cultivation will ever raise a second-class wheat field into the first class.

[1] Sir E. J. Russell and D. J. Watson, Imperial Bureau of Soil Science Technical Communication No. 40, 1940. 7s. 6d.

FORTHCOMING EVENTS

[*Meeting marked with an asterisk is open to the public.*]

Monday, May 12

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W. 7), at 5 p.m.—Sir Charles Arden-Close, F.R.S., Mr. F. S. Richards, Mr. Arthur R. Hinks, F.R.S.: "Map Projections and Sun Compasses".

Tuesday, May 13

ROYAL SOCIETY OF ARTS (at the Institution of Electrical Engineers, Victoria Embankment, London, W.C.2), at 2.30 p.m.—Lieut.-General A. G. L. McNaughton: "Research in Canada".

ROYAL INSTITUTION OF GREAT BRITAIN (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Dr. Alexander O. Curle: "Glimpses of 2,000 Years of Home Life: as Revealed by Excavations in the North of Scotland".*

INSTITUTE OF PHYSICS (London and Home Counties' Branch) (in the Lecture Hall of Messrs. Kodak, Ltd., Harrow), at 6 p.m.—Dr. C. Sykes: "Thermal Effects in Transformations in Metals".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN MECHANICAL ENGINEERING at the Leeds College of Technology—The Director of Education, Education Department, Calverley Street, Leeds 1 (May 19).

DEPUTY BOROUGH ELECTRICAL ENGINEER in the Electricity Undertaking of the Woolwich Metropolitan Borough Council—The Borough Electrical Engineer, Electric House, Powis Street, Woolwich, London, S.E.18 (May 19).

LECTURER (GRADE 2B) IN ELECTRICAL ENGINEERING—The Registrar, University, Leeds (May 19).

MANAGER OF THE WROUGHT LIGHT ALLOYS DEVELOPMENT ASSOCIATION—Mr. Eric L. Heathcote, Wrought Light Alloys Development Association, 25 Bennetts Hill, Birmingham 2 (June 7).

PROFESSOR OF MATHEMATICS—The Bursar and Deputy Registrar, University College of North Wales, Bangor (June 30).

GRADUATE TEACHER IN ENGINEERING at Kenrick Technical College—The Director of Education, Education Offices, Highfields, West Bromwich.

ASSISTANT ENGINEER FOR THE SUDAN RAILWAYS—The Controller, Sudan Government London Office, Oxford Hotel, 261 Clifton Drive South, Lytham St. Annes, Lancs. (quoting 'Assistant Engineer').

ASSISTANT ENGINEER in the Government of Zanzibar Public Works and Electricity Department—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1 (quoting M/9634).

TEACHER OF ENGINEERING SUBJECTS—The Principal, Technical School, Cole Street, Scunthorpe, Lincs.

REPORTS AND OTHER PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

National Central Library. 24th Annual Report of the Executive Committee, 1939–1940. Pp. 16. (London: National Central Library.) [244

Proceedings of the Royal Society of Edinburgh. Section B (Biology). Vol. 61, Part 1, No. 4: The Hydroid of the Medusa *Cosmetira pilosella* Forbes. By W. J. Rees. Pp. 55–58. (Edinburgh and London: Oliver and Boyd.) 6*d*. [234

Other Countries

Field Experiments on Sugar Cane in Trinidad—Annual Report for 1940. By P. E. Turner. Pp. 260. (Trinidad: Government Printer, Port-of-Spain.) [234

Department of Science and Agriculture, Jamaica. Bulletin No. 25: Reprints of Miscellaneous Articles, 1938. Pp. iii+92. 6*d*. Bulletin No. 26: Banana Leaf Spot Investigations, 1: The Basis of Control. By R. Leach. Pp. ii+8. 6*d*. (Kingston: Government Printer.) [234

Proceedings of the United States National Museum. Vol. 89, No. 3098: Echinoderms from Greenland collected by Capt. Robert A. Bartlett. By Austin H. Clark. Pp. 425–434+plate 58. Vol. 89, No. 3103: *Disotocrinus*, a New Fossil Inadunate Crinoid Genus. By Edwin Kirk. Pp. 513–518+plate 63. Vol. 89, No. 3014: A Supposed Jellyfish from the Pre-Cambrian of the Grand Canyon. By R. S. Bassler. Pp. 519–522+plate 64. (Washington, D.C.: Government Printing Office.) [234